

THE D. H. HILL LIBRARY
NORTH CAROLINA STATE COLLEGE



THE FRIEDRICH F. TIPPMANN

ENTOMOLOGICAL COLLECTION

453167

This book may be kept out TWO WEEKS ONLY, and is subject to a fine of FIVE CENTS a day thereafter. It is due on the day indicated below:

--	--	--

INJURIOUS INSECTS

OF

INDIAN FORESTS

BY

E. P. STEBBING, F.E.S.,


INDIAN FOREST SERVICE.



CALCUTTA :

OFFICE OF SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.

1899.



Digitized by the Internet Archive
in 2009 with funding from
NCSU Libraries

PREFACE.

IN compiling the pamphlet entitled "Injurious Insects of Indian Forests" the author does not pretend to have aimed at producing a work containing original research in this subject. The information included in it has been chiefly culled from scattered notes that have appeared from time to time in the publications known as *Indian Museum Notes*, published by the Trustees of the Indian Museum, Calcutta, and the *Indian Forester*. Mr. Thompson's Report on Insects destructive to Woods and Forests (1868) has been also consulted. This scattered information has been pieced together in a readable form, and an endeavour made to, wherever possible, give the life history, as far as it is as yet known, of various forest insect pests. A few notes and observations made by the writer since he joined the Forest Service in India in 1893 have been entered, these forming practically the only new original matter in the pamphlet. It will be noticed that in many instances accounts of individual attacks on trees and other notes of the most fragmentary nature have been included, although it has been found impossible to give any name to the aggressor, owing to the paucity or bad quality of the specimens sent for identification. Especial care has been taken that in all these accounts the name of the Forest or Forest Division from which the attack was reported should be mentioned. It is hoped that their attention being thus drawn to the matter, Officers at present in charge of these divisions will endeavour to

collect specimens of the pests in all stages, noting down dates of emergence in each, and all other obtainable information about their life histories. In this manner our knowledge in this subject, a by no means unimportant one to the Forest Officer, will soon be steadily on the increase, and the publication of a Manual on Indian Injurious Forest Insects may not be the impossibility it at present has the appearance of being. As has been already mentioned above, the writer's present aim has been solely to give, in a small, compact and handy pamphlet, all the information at present available on the subject of our Indian Injurious Forest Insects. He trusts that his brother Officers and others may find the pamphlet useful as a guide and help; and that it may prove to be a step in the direction of largely increasing our knowledge of the life histories of those most indefatigable enemies—our Insect Foes.

CHITTAGONG, BENGAL; }
April 25th, 1898. }

E. P. STEBBING.

INSECTA.

CHAPTER I.

ORTHOPTERA.

ORTHOPTERA GENUINA.

SALTATORIA.

The injury that arises from the attacks of the *Saltatoria* group of the *Orthoptera genuina* is chiefly due to defoliation, the young shoots of trees and seedlings being eaten. The group includes the family *Locustidæ* which contains some of the most destructive insects of the world—insects who, when swarming in their millions, leave ruin and famine in their wake.

The following trees are mentioned as attacked by species of the group, but during serious locust invasions most trees suffer more or less.

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
ACRYDIIDÆ	1. Chir (<i>Pinus longifolia</i> , Roxb.)	• Young plants eaten.
	2. <i>Robinia</i> sp.	• Young seedlings killed.

Family I.—*Acrydiidæ*.

The family includes the various species of locusts that periodically invade the fertile plains of India with such disastrous results.

1. *Acrydium peregrinum*, Oliv.

Oliv. Voy. Emp. Othom. ii, 424.

Tree attacked.—During bad invasions of this insect various forest trees are stripped of their leaves and young shoots.

Egg.—The home of this insect is in the sandy deserts of Sind and Western Rajputana, and eggs are laid here in holes in the ground.

The insect is said to breed in these deserts every year in varying numbers. When the locusts invade the fertile plains of India it has been noticed that they lay their eggs at the beginning of the

South-West monsoon, *i.e.*, about June. The eggs are attached to one another by a cohesive siccable substance and are of a dirty yellow colour.

Larva.—The larvæ are at first little black wingless grasshoppers. They change their skins during development about five times, the young wings first appearing at the fifth change, the larva being yellowish-pink in colour. The changes of skin take place about every fifteen days until the fully developed insect is obtained.

Imago.—The sixth change of the larval skin gives the full grown imago with fully developed wings.

The imago is a big thick-set grasshopper with short antennæ. When it first acquires wings it is salmon-pink in colour, but as it gets older it becomes yellowish and afterwards dull purple in tint. The insect feeds voraciously throughout this stage of its life, as also during the larval stage.

Locality from where reported.—This locust periodically does enormous damage, and its invasions are a source of great danger to the cultivator in India, since famine is liable to follow in the wake of bad attacks of the pest. It invades the fertile plains of India from its home in the sandy deserts of Rajputana, Sind, and the Punjab, and in the line it takes not a green leaf or shoot is left either in the forest or field.

The locust only leaves the sandy arid wastes which are its home when they become over-populated, and the life history of the pest readily proves that forests and moisture are its greatest enemies. The reclamation of arid sandy areas by means of plantations would thus have a tendency to check the multiplication of this pest.

2. *Caloptenus* sp.

Tree attacked.—Chir (*Pinus longifolia*, Roxb.).

In July 1891 a number of Orthopterous insects were sent to the Indian Museum, Calcutta, through the Director of the Forest School, Dehra Dun, from the officiating Conservator of Forests, Central Circle, North-Western Provinces and Oudh, with the information that they had proved destructive to chir in the Baldhoti plantation, where they were reported as nipping off the young trees in a plantation.

An examination in the Museum of the specimens sent proved that they comprised four species of *Acrydiidæ*, of which *Caloptenus* sp. was one. The other species were *Chrotogonus* sp. *Calantops indicus* and *Edalus* sp.

3. *Chrotogonus* sp.—

Tree attacked.—Chir (*Pinus longifolia*, Roxb.).

Imago.—This insect is a small thick-set brown grasshopper which seems to be very destructive to crops of all kinds. It bites off the young plants as soon as they appear above ground. Of the four species reported as attacking young chir plants this is thought to be the one that does the most damage, the genus being by far the most numerous amongst the specimens sent to the Museum.

Locality from where reported.—The pest was reported as having proved destructive, in company with *Caloptenus* sp., *Catantops indicus* and *Edalus* sp., to young chir plants in the Baldhoti plantation, North-Western Provinces.

4. *Chrotogonus trachypterus*, Blanch—A. S. E. F. V. 618. pl. 22, f. 6.

Tree attacked.—*Robinia* sp.

In September 1893 a number of *Acrydiidæ* were forwarded through the Director of the Imperial Forest School, Dehra Dun, to the Indian Museum, Calcutta, from the Chenab Division in the Punjab, with the information that they destroyed young *Robinia* seedlings by nipping them off at the base.

On examination of the specimens at the Museum it was found that they consisted of five species of *Acrydiidæ*, of which *Chrotogonus trachypterus* proved to be one. Of the other species *Epnecromia dorsalis*, *Edalus marmoratus*, and (?) *Acrotylus* sp. were identified in the Museum.

These species are mentioned below.

5. *Catantops indicus*, Saus.

Tree attacked.—Chir (*Pinus longifolia*, Roxb.).

This insect has been reported, as mentioned above, as nipping off young chir plants in the Baldhoti plantation, North-West Provinces, in company with *Caloptenus* sp. *Chrotogonus* sp. (both mentioned above) and *Edalus* sp.

6. *Edalus* sp.

Tree attacked.—Chir (*Pinus longifolia*, Roxb.).

This is the last of the four *Acrydiid* insects that have been reported as killing young chir plants in the Baldhoti plantation. The life histories of these insects do not seem to have been as yet worked out.

7. *Edalus marmoratus*, Thunb.

Thunb. Mem. Acad. Peterb, V, 1815, 232; Id. IX, 1824, 410, t. 14, fig. 3.

Tree attacked.—*Robinia* sp.

This is the second of the *Acrydiid* insects reported as attacking

and killing young Robinia seedlings in the Chenab Division, Punjab.

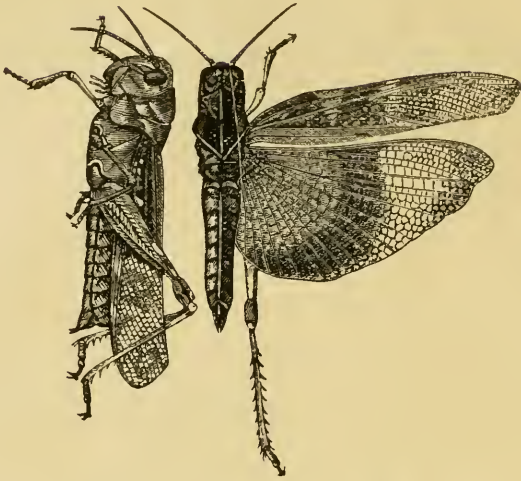


FIG. 1.—*Edalul marmoratus*.

Fig. 1 shows the imago, dorsal and side view.

This insect has also been reported as destructive to crops.

8. *Epacromia dorsalis*, Thunb.

Tree attacked.—*Robinia* sp.

The species is the third of the Acrydiid insects reported as killing young Robinia seedlings in the Punjab.



FIG. 2.—*Epacromia dorsalis*.

Fig. 2 shows the dorsal and side view of the imago of this insect, natural size. *E. dorsalis* has also been reported as attacking crops.

9. (?) *Acrotylus* sp.—

Tree attacked.—*Robinia* sp.—

This is the fourth of the insects which were reported to have killed young *Robinia* seedlings in the Chenab Division of the Punjab.

No further notes on the life histories of these insects seem to have been reported.

Family II.—*Locustidae*.

1. *Schizodactylus monstrosus*, Brullé. *Hist. Nat. des ins.* tom. IX, p. 162, pl. 17, fig. 1.

Tree attacked.—None reported.

This species, as will be seen in the figure, can be at once recognised by the curious structure of its tarsal joints and also, in the adult, by its curious curled up wings. It is known in the indigo districts as ‘bherwa,’ and does a large amount of damage by

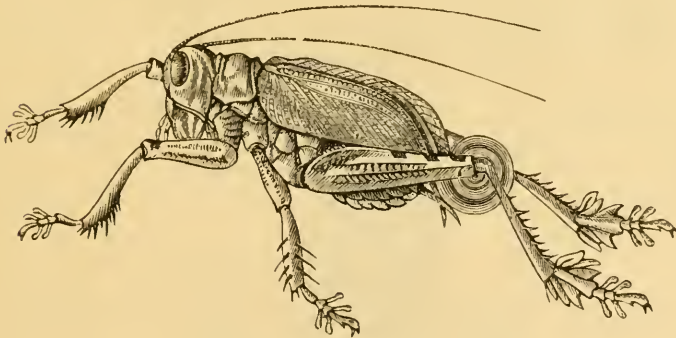


FIG. 3.—*Schizodactylus monstrosus*.

cutting off indigo, tobacco, and other crop-plants with its enormous shear-like jaws.

Locality from where reported.—The pest has been reported from various parts of Bengal as attacking crop plants. It has not been as yet noticed to do any damage in forest nurseries or young plantations, but it is not unlikely that when more is known of their habits, this family of the *Acrydiidae* may prove to be as troublesome pests to the forester as are some of their confrères in Europe.

Figure 3 shows the adult male of this insect, natural size.

ORTHOPTERA PSEUDONEUROPTERA.

This division of the Orthoptera contains one of the most destructive pests of the insect kingdom, the so-called 'white ant' or Termite. It may perhaps be said of this insect that in the forest alone does it render any service to man. Here it is beneficial in keeping the forest clean, by rapidly converting all fallen branches, dead trees, and decaying wood of all sorts into mud, each particle of wood eaten being replaced by earth.

Family III.—*Termitidae*.

1. *Termes taprobanes*, Walker.

Walker. List Neurop. Ins., B. M., Pt. III (Termit), p. 252. 29.

Tree attacked.—Sickly trees, dry timber, and dried vegetable matter, etc., etc.

This species is the common 'white ant' of Lower Bengal. It forms large earthen nests, often from six to eight feet in height. These nests are very common in the sâl forests of the Singhbhum Division, Chota Nagpur. The following is said to be the life history of *Termes taprobanes*.

The insect lives in communities which consist of the following four sets of individuals :—

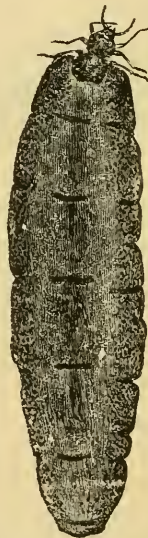


FIG. 4.—*Termes taprobanes*—Female or Queen.

- (1) A female or queen (shown in Figure 4, natural size) with enormously distended abdomen; she is in-

capable of locomotion and lays all the eggs of the community.

- (2) Small ant-like neuters, which may be compared to the worker bees. They are of two kinds, *viz.*, individuals



FIG. 5.—*Termes taprobanes*—Two forms of neuters.

with large heads and sharp mandibles to defend the nest, and individuals with small heads to build the passages and nests, collect food, and do all the work of the community. Figure 5 shows the two forms of neuter, both somewhat enlarged, natural size in each case is shown by a hair line.

- (3) Wingless larvæ which develop into winged males and females. This form is shown in Figure 6 to the left, enlarged, natural size being indicated by a hair line.

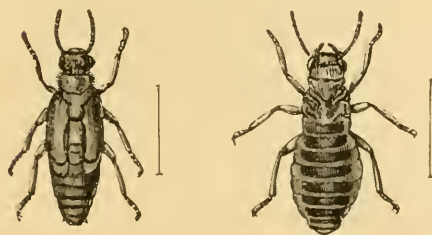


FIG. 6.—*Termes taprobanes*—Larva of winged forms and a young queen.

- (4) Winged males and females.—The males and females fly out of the nest in clouds, generally after rain.

Those of them that escape their numerous enemies are said to drop their wings and copulate. The female finds her way back to the original nest or starts a fresh nest for herself. Her abdomen grows by distention of the membranes between the chitinous plates, until she becomes like a sausage, two or three inches in length, with a minute head and thorax at one end (Figure 4). Queens in several stages of development may sometimes be found in a single nest. Figure 6 to the right shows a young queen shortly after dropping her wings and before the abdomen has grown very much; natural size of the insect indicated by a hair line.

Figure 7 below shows one of the winged forms, natural size.



FIG. 7.- *Termes taprobanes* - Winged form.

Termes taprobanes never willingly exposes itself to daylight (except in the male and female forms). The insects work in earthen galleries, which they build over themselves as they advance. The trunks of the sâl trees in the Singhbhum sâl forests of Chota Nagpur are generally bright red in colour. Owing to the work of white ants the bark is covered with galleries made of the red loamy soil. In these forests, where white ants are numerous, the insects only feed on the outer dead portions of the bark of the trees, but do no damage to healthy trees. The instinct of these insects is marvellous. The writer has often noticed that should a tree have a dead branch on its trunk, no matter at what elevation, an earthen gallery is run up by the white ants and the branch attacked, the decaying wood being replaced by soil, which soon drops to the ground.

As has already been mentioned, white ants do good in the forest by converting in a very short space of time all dead wood into soil. On the other hand, they attack, in the same way, timber if left any length of time in the forest for seasoning or other reasons. The writer noticed that sâl sleepers, left lying for eight months in the

Singhbum forests, were often very badly attacked by these insects and their value greatly impaired.

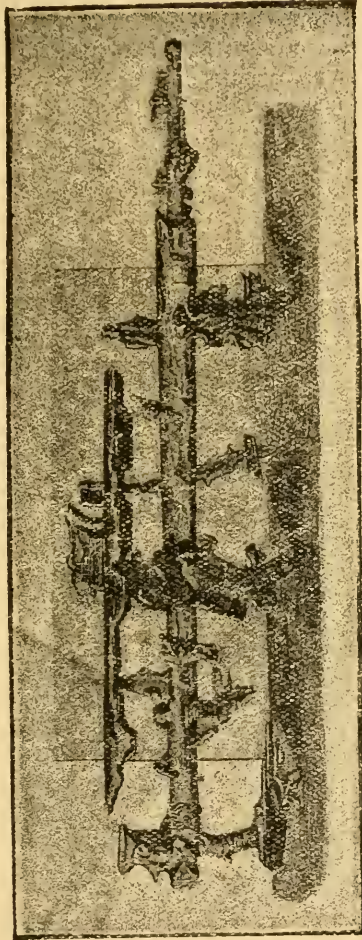


FIG. 8.—Remains of a beam of wood attacked by *Termes taprobanes*.

Figure 8 shows the remains of a beam of wood from the neighbourhood of Calcutta, which had been attacked by white ants, the species responsible being probably *Termes taprobanes*. The figure, which is about one-seventh natural size, shows the supports left by the insects to bear the weight of the earth and rubbish they lay above the beam. Most of these supports, but not all of them, consist of a knob in the centre strengthened by a little of the surrounding wood-tissue.¹

¹ I would recommend the reader if interested in these marvellous insects to read a pamphlet entitled the "Constitution and development of the Society of Termites; observations on their habits," by Professor B. Grassi, in collaboration with Dr. Sandias, translated by W. F. H. Blandford, M.A., F.Z.S., and published in the *Quarterly Journal of Microscopical Science*, Vols. 39 and 40.

I may mention here that the popular theory that a white ants, nest may be got rid of by digging up and killing the queen is a fallacy. It has been recognised that termites are perfectly well aware of the presence or absence of the king and queen, and should they be removed the workers start about providing fresh ones, *i.e.*, substitute royal forms, by introducing deviations in the normal development of the larvæ. Thus it becomes almost impossible to eradicate white ants.

CHAPTER II.

HEMIPTERA (RHYNCHOTA).

HOMOPTERA.

This group of the *Hemiptera* contains species which attack the branches, young shoots, leaves, flowers and fruits of Indian Forest trees, as shown in the following list :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
COCCIDÆ	1. Mango (<i>Mangifera indica</i> , Linn.).	Leaves, flowers, and young shoots injured.
	2. Ceara rubber (<i>Manihot Glaziovii</i> , Müll. Arg.).	?
	3. Suparee Nut Palm (<i>Areca catechu</i> , Willd.).	Fruit (nuts) destroyed.
	4. Coconut (<i>Cocos nucifera</i> , Linn.).	Leaves injured.
	5. <i>Codreia</i> , sp.	Twigs injured or killed.
	6. Mandania, N. (<i>Aerocarpus fraxinifolius</i> , Wight).	Do.
	7. Sunkong-kung (<i>Ficus mysoensis</i> , Heyne).	Do.
	8. Kathgôlar (<i>Ficus glomerata</i> , Roxb.).	Do.
	9. Karwat (<i>Ficus asperima</i> , Roxb.).	Do.
	10. Oak (<i>Quercus</i> sp.) . . .	Leaves injured.
	11. Chestnut (<i>Castania</i> sp.) .	Do.
APHIDE	1. Cinchona (<i>Cinchona</i> , sp.) .	Do.
	2. Terebinth tree (<i>Pistacea terebinthus</i> , Linn.).	Galls produced on branches.
	3. Poplar (? <i>Populus euphratica</i> , Olivier).	Do. on twigs.
	4. Aspen (<i>Populus tremula</i>).	Do. do.
	5. Bamboo (<i>Bambusa arundinacea</i> , Retz.).	Leaves injured.
	6. Himalayan spruce fir (<i>Abies smithiana</i> , Forbes = <i>Picea Morinda</i> , Link.).	Shoots crippled and stunted.
PSYLLIDÆ	1. Mango (<i>Mangifera indica</i> , Linn.).	Galls produced on shoots.
	2. Kaikar (<i>Garuga pinnata</i> , Roxb.).	Galls produced.
CERCOPIDÆ	1. Farash tree (<i>Tamarix articulata</i> , Vahl.).	Twigs dry up.
CICADELLIDÆ (Jasside).	1. Mango (<i>Mangifera indica</i> , Linn.).	Leaves, flowers and young shoots injured.

Family I. *Coccidæ* (Scale Insects).

Of this family Cotes remarks¹:—"They are minute insects and do an enormous amount of damage to vegetation and are likely to prove extremely destructive in Indian forests, though little has yet been recorded on the subject". This statement is perhaps

¹ Manual of Zoology by E. C. Cotes, page 19 (1893).

somewhat doubtful, but at present very little is known on the subject.

1. *Lecanium acuminatum*, Sign.—

Sign. Ann. Soc. Ent. France, p. 397, t. 12, f. 1, (1873).

Tree attacked.—Mango (*Mangifera indica*, Linn.).

This insect was found attacking this tree by Mr. Green in Ceylon.

Only the adult form has been obtained and it is described as follows:—

Body briefly oval, acuminate towards the apex, rounded, very broad towards the extremity; antennæ seven-jointed, fourth longest, third equal to the fifth and sixth taken together, which are the shortest, the seventh as long as the fifth and sixth taken together. Feet broad flattened; tarsi short, hardly half the length of the tibiæ. Length 2-3mm.

Locality from where reported.—This coccid is reported by Mr. Green to do some damage to the leaves of the mango tree in Ceylon. The leaves are said to wither and fall off when attacked. Plate I (1) shows this insect, (b) shows the ventral surface (after Signoret), (a) the dorsal surface and (c) a side view, the two latter magnified about seven times.

2. *Lecanium nigrum*, Nietner.

Nietner, Enemies of coffee tree, p. 9, (1861); *Jour. A. S. B., Calc.*, p. 284, (1886).

Tree attacked.—Ceara rubber (*Manihot Glaziovii*, Müll. Arg.).

This insect is known as the 'black bug,' and has been found attacking the ceara rubber (*Manihot Glaziovii*) in Ceylon and also coffee bushes.

No report of the damage done seems to have been made.

3. *Chionaspis aspidistræ*, Sign.

Sign. Essai sur les Cochenil, p. 125, (1868).

Tree attacked.—Suparee nut palm (*Areca catechu*, Willd.).

In October 1890 the Museum at Calcutta received specimens of the above insects from Mr. Marshall Woodrow of Poona. The coccid was said to attack the *suparee* in the Janjira State on the coast about eighty miles south of Bombay, the outturn of dressed betel-nuts having been reduced by the ravages of the pest from 10 lbs. to 1 lb. per tree. The trees were said to have suffered for the last twenty-five years from this insect, which has become specially troublesome during the past six or seven years.

The specimens were identified by Mr. Maskell, who wrote as follows:—

"The insect is, as regards the female, so much like *Chionaspis aspidistræ* that I may consider it identical with that species. The

female puparium agrees in its yellow colour and pyriform shape; the second pellicle is rather large; and the enclosed insect has the remarkably prominent abdominal segments as shown in the rough sketch of *C. aspidistræ*. I could not amongst the numerous specimens discover any male puparia. These would be small, white, narrow and carinated."

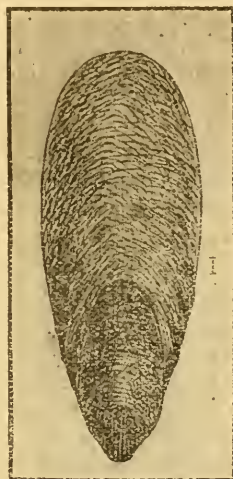


FIG. 9.—*Chionaspis aspidistræ*. FIG. 10.—*Chionaspis aspidistræ*.

Figure 9 shows the female with the remarkably prominent abdominal segments.

4. *Aspidiotus destructor*, Sign.

Essai sur les cochenilles, p. 94; *Ann. Soc. Ent. France*, 1868, p. 120, figs. 1—4.

Tree attacked.—Cocoanut (*Cocos nucifera*, Linn.)

This coccid has been reported as extremely injurious to the cocoanut tree in the Laccadive Islands and in the Isle de Réunion. It is a minute insect which to the naked eye looks like a mealy scurf on the leaves. It sucks up the juices of the leaves to such an extent as to sap the vitality of the trees and to destroy great numbers of them.

This insect is found attacking the cocoanut in this way in company with *Dactylopius cocotis*, Maskell.

The Indian Museum, Calcutta, only contains species of *A. destructor* from the Laccadive Islands, and no mention is made in Indian Museum Notes of cocoanut trees having been attacked in India by this pest.

In the *Indian Forester*¹ Mr. A. M. Sawyer wrote from Travancore, stating that in the central and northern districts they had lost several cocoanut trees from decay of the tender unexpanded leaf shoots. Mr. Sawyer described the disease as follows:—

"At first the lower end of the shoot grows discoloured and in

¹ *Indian Forester*, Vol. XX, September 1894.

a few days general putrefaction of this and more or less of the cabbage ensues; the shoot droops and in some cases falls to the ground; the tree decays soon after and we are left lookers-on and losers."

In his note Mr. Sawyer stated that the death of the tree was not due to *Oryctes Rhinoceros* or *Batocera rabus*, both beetles which bore into the cocoanut tree.

The writer in a later *Forester*¹ discussed this attack and was of opinion that it might be due to *A. destructor* or *Dactylopius cocolis* (mentioned on page 15), the pests which are so destructive to cocoanuts trees in the Laccadive Islands, etc. Neither of the insects have been reported in this connection from India, but it by no means follows that they do not exist in the country.

The matter rests here at present, as no further communication on the subject has been made by Mr. Sawyer.

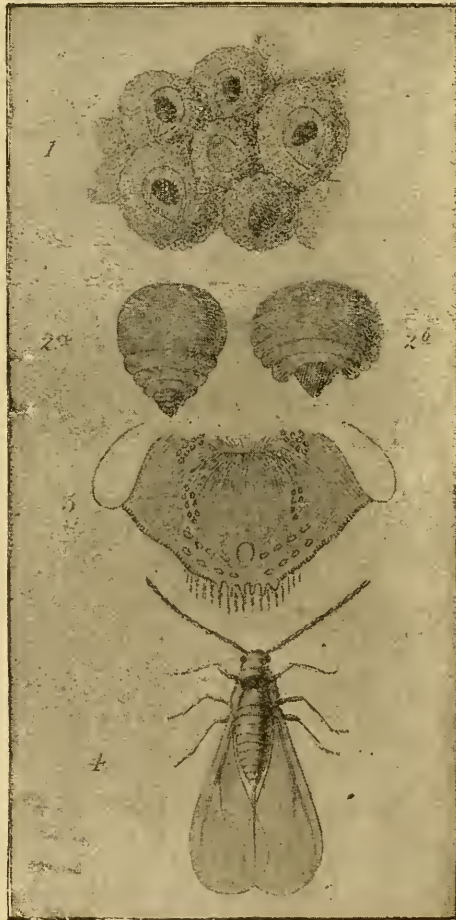


FIG. 11.—*Aspidiotus destructor*.

Indian Forester, Vol. XX, December 1894.

The figure, fig. 11, shows (1) aggregation of ♂ and ♀ puparia, ♂ with one pellicle, ♀ with two (the insects are removed); (2) adult ♀'s, *a*, before gestation, *b*, after gestation; (3) Pygidium of ♀ (after Signoret); (4) adult ♂.

5. *Dactylopius adonidum*, Linn.—

Linn. Syst. Nat., p. 740, (1767); *Jour. A. S. B. Calc.*, pt. II, p. 288, 1886.

Tree attacked.—*Cedrela* sp; *Acrocarpus fraxinifolius*, Wight; *Ficus mysorensis*; *Ficus glomerata*, Roxb.; *Ficus asperrima*, Roxb., and others (names not given) are also stated to be attacked by the pest.

This insect, which has been described in the *Journal of the Asiatic Society*,¹ has been procured from Mysore, where it occurs on the above-mentioned trees, and also does considerable damage to coffee bushes.

A remarkably curious black fungoid growth seems invariably to accompany this insect, and covering the twigs effectually rots and kills them. It has been described as a black, felted substance extremely like a fungoid growth; in appearance it is very like the sooty accumulation that occurs on bottles in wine cellars.

Of this fungoid growth Mr. Nietner writes:—

“As the occupation of a coffee or any other tree (by *coccidæ*) gives rise to the appearance of a glutinous saccharine substance (honey dew, which is either a secretion of the scale, or its extravasated sap that flows from the wounded tree, or more probably a combination of both) which disappears with the scale and as the fungus does exactly the same, I have no doubt that its vegetation depends upon the glutinous saccharine substance.”

Mr. Anderson also noticed this honey dew in connection with *D. adonidum* in Mysore, and wrote that “the tree, when attacked, bleeds or gums so profusely that the ground all round the stem is made moist.”

6. *Dactylopius cocotis*, Maskell—

Trans. N. Z. Instit., 1889, Vol. XXII, p. 149.

Tree attacked.—Cocoanut (*Cocos nucifera*, Linn.).

This insect, as mentioned on page 14, attacks the leaves of the cocoanut in company with *Aspidiotus destructor*, though the latter insect is thought to do the most damage.

The insect as found in the Laccadive Islands differs slightly from the *D. cocotis* found on the Fiji cocoanuts, inclining more to yellow than red in colour and having often only seven joints in the antennæ. It may prove to be a variety of the true *D. cocotis*.

¹ Part II, page 238 (1886).

The insect has not as yet been reported from India, unless Mr. Sawyer's account of the injury done to cocoanuts in Travancore proves to be due to *Aspidiotus destructor* and *D. cocotis*.

7. *Pseudo-pulvinaria sikkimensis*, Atkinson in litt.

Trees attacked.—*Cinchona* sp., Oak (*Quercus* sp.), Chestnut (*Castania* sp.) This insect when reported appeared to be new to science and was put by Mr. Atkinson, who described it, into a new genus which he named *Pseudo-pulvinaria*.

The insect appears in the cold weather in the form of a flour-like substance on the under-side of the leaves of oak, chestnut and cinchona, and matures about April. It is stated that it has not yet been reported to do any considerable damage to the leaves of these trees.

8. *Ceroplastes ceriferus*, Sign. White insect wax.

Sign. Ann. Soc. Ent. France (5), Vol. II, p. 40 (1872).

Trees attacked.—Asan (*Terminalia tomentosa*, W. and A.), Harra (*Terminalia chebula*, Retz), Pipal (*Ficus religiosa*, Linn.), Mango (*Mangifera indica*, Linn.), etc. This insect is mentioned here as it lives on a variety of trees though the writer does not consider it does much damage. It was at one time thought that it would have a commercial value, as it resembles the Chinese *Eriocerus pela*, which has long been cultivated in China, the wax being used in candle-making. The wax of *C. ceriferus* has been found, however, to burn with too smoky a flame.

The writer has found the insect on most of the above trees in Chota Nagpur (Singbhum).

NOTE.—*Carteria lacca*, Kerr, and *Coccus cacti*, Linn. Neither the lac insect (*Carteria lacca*, Kerr) nor the cochineal insect (*Coccus cacti*, L.) which are both coccids are mentioned in the above list. They are so obviously useful as revenue yielders, more especially the lac insect, that they can hardly be termed forest pests.

Carteria lacca, Kerr—

Kerr. Phil. Transact. (1781), 374, figs. a, b.

The lac insect feeds on a number of trees a list of which is given in Appendix B. They feed on the young twigs of the tree, sucking up their juice.

LARVA.—When the larvæ or grubs escape from their eggs they crawl about in search of fresh sappy twigs. When satisfied they become fixed, sucking up the sap by means of their beak or proboscis, with which they have pierced through the young bark. In this position they form a sort of cocoon by excreting a resinous substance. The male cocoon is ovoid in shape, the female circular. In about 2½ months the female has become matured and also the male. The female, however, remains *in situ* and throws up around itself a more perfect coating of resin, and this is the lac which has a commercial value.

Coccus cacti, Linn.

Lin. Syst. Nat. (1736), 742, 22.

Coccus cacti, the cochineal insect is not indigenous to India, but was introduced in 1795, when it was placed on the indigenous *Opuntia*, on which it was found to thrive very well.

The insect has a large commercial value.

Family II.—*Aphidæ*.

This family have been reported as attacking the leaves of trees and also distorting the branches by the formation on them of galls.

1. *Pemphigus cinchona*, Buckton—*Buckton in litt.*

Tree attacked.—*Cinchona* (*Cinchona* sp.)

This is a minute insect found feeding on cinchona in Sikkim, but it has not been noticed as doing much damage.

2. *Pemphigus edificator*, Buckton—

Buck. Ind. Mus. Notes, Vol. III, No. 1, pp. 71-73.

Tree attacked.—*Pistacea terebinthus*, Linn.

This pest forms galls on *Pistacea terebinthus*. Both insect and galls have been described by Mr. Buckton as follows:—

“These galls were of various sizes, some of them measuring as much as 4·5 inches or 11·5 c.m. in length, whilst others did not exceed the size of a small walnut. In width they were about 3·0 c.m. The larger kinds had somewhat of the appearance of contorted figs more or less compressed and indented; but probably they were more cylindrical when fresh and green. Their prevailing colour was ferruginous-yellow or reddish. Surfaces were furrowed longitudinally with shallow streaks.

“The gall-like bodies seem to be formed directly from the leaf stalks of the trees and not from the leaves. Whilst some were pyriform, others had a singular contorted shape, and were twisted like a corkscrew. They terminated at their summits in a horny point.

“When cut across they showed hard woody walls varying in thickness. Each had but a single cavity without partitions, and in some cases the outer walls were perforated by one or two small round holes the size of large shot, by which the mature insects escape.”

The galls examined by Mr. Buckton contained winged and apterous *Aphidæ*.

Imago.—Imago wholly black. Head small, furnished with normally formed eyes and the usual supplementary eyelet; antennæ half the length of the body, seven-jointed, counting the terminal process as a joint. Third and sixth joints the longest and apparently not tuberculated. Notum and pronotum broad; abdomen ringed and tapering to a rounded cauda. Nectaries not visible. Legs black, the hinder pair hirsute. Tarsus two-jointed with claws. Upper wings about twice the length of the body. Costal edge strong with a broad black cubital vein, ending beyond the middle of the costa with a broadly banded black stigma, having an internal dark cell. Stigmatic vein long and curved. Second

vein short and disconnected from the cubitus. Third vein joined to the cubitus and widely forked close to its insertion.



FIG. 12.—*Pemphigus edificator*.

The figure, Fig. 12, shows the winged insect with diagrams of its antennae and legs. The size of the specimens is indicated by hair lines. The gall shown is half natural size.

Locality from where reported.—The galls were obtained by Mr. C. F. Elliott, who found them on the twigs of *Pistacea terebinthus*. The trees were discovered in November 1891 growing in a forest in the dry bed of a broad stony ravine about 3,000 feet above the sea-level near Harnai, on the Sind-Peshin section of the North-Western Railway, Baluchistan. Almost every tree had a dozen or more of these galls towards the extremities of the branches. The galls were of every shape, some empty, some opening and the flies swarming out, some still with the young insects closed up inside.

3. *Pemphigus napæus*, Buckton—

Buck. Ind. Mus. Notes, Vol. IV, No. 2, pp. 50-51.

Tree attacked.—Poplar (? *Populus euphratica*, Olivier).

This insect forms galls on the twigs of the poplar tree. The galls have a shining green surface, slightly veined with brown, and variegated with yellowish patches.

They are mostly roundish ; but some occur of irregular shapes, about 1.10×0.50 inches in measurement.

When cut open they show a single chamber tenanted by twenty or more insects, some of which are in the pupal and others in the winged form. The alate insects are of two sizes, one being about twice the size of the other. A much larger female, which is blind and apterous, may also be found ; she is the foundress of the colony and originally produced the first walls of the gall-structure.

An aperture at the side affords an exit for the winged females when they are matured.

Pupa.—Pupa entirely yellow ; size 0.15 inch.

Foundress.—Globose, shining yellow. Antennæ very short, black, and obscurely five-jointed. Rostrum stout and short. Eyes none, legs black. Size 0.11×0.9 inches.

Winged Imago.—The winged female may be thus described :—Body robust. Head and thorax, both above and below, shining black. Abdomen pale, greenish yellow, smooth and immaculate. Antennæ black, and about the length of the abdomen. First two joints globose, third joint ringed and about equal to the fourth and fifth taken together, the sixth ending in a blunt nail, and equal to the fifth. Eyes large with the usual superimposed tubercle. Nectaries none. Legs black with rather long tarsi. Upper wings ample with rounded tips. Veins, fine and black, with a conspicuous dark stigma. The neurulation approaches that of a *Schizoneura*, inasmuch as the third vein does not meet the cubital. Notwithstanding this peculiarity Mr. Buckton regards this insect as a *Pemphigus* and nearly allied to *P. spirotheca* of Koch, which in Europe also forms globular galls on the poplar (*Populus nigra*).

The expanded winged female measures 0.36×0.11 inch. The rostrum is short and equal to the width of the thorax. The smaller-winged forms are believed to belong to an earlier brood as they do not appear to be males. Plate II (1) shows various stages of this insect.

Locality from where reported.—This homopterous insect forms smooth rounded galls on the twigs of the poplar tree growing at an elevation of 9,000 feet in the Valley of the Yasin River, near the Darkot Pass.

4. *Pemphigus immunis*, Buckton—

Buck. Ind. Mus. Notes, Vol. IV, No. 2, p. 51.

Tree attacked.—Aspen (*Populus tremula*.)

This insect forms rather large galls, 1.20×1.10 inches, on the aspen tree. Specimens gathered at an elevation of 4,600 feet and preserved in alcohol show a hard woody exterior ; sometimes they have a rough surface, like that of a walnut shell, whilst others

show a *quasi*-imbrication, as seen in the figure. The interior is thrown into smooth but deep furrows. The aperture near the apex has rough corrugated edges, or lips, like the excrescences made by *P. bursarius* of Europe. The galls made by *P. immunis* are much larger than those made by *P. napæus*, and they differ in several particulars from those made by *P. bursarius*.

Pupa.—The pupæ are stout, ovate, greenish yellow, with short wing cases and dark legs. They are numerous in the interior of the galls. Size 0.08×0.04 inch.

Imago.—Winged viviparous female. Head and thorax more or less shiny piceous brown, not black. Antennæ short, black, five or obscurely six-jointed, the third joint hardly at all ringed; the last joint often dilated at the tip. The wing veining is much like that of *P. napæus*, but much paler, and the stigma faintly brown. All the upper side of the thorax brown; but this tint is confined to a saddle-shaped dark spot on the sternal aspect. Eyes rather small, legs black. The whole insect is more slender and more ovate than is seen in *P. napæus*. In the colour of the thorax and abdomen it also differs from *P. bursarius*. These characters, coupled with the different habitats, justify a separation from either of these species. Plate II (2) shows several stages in the life history of this *aphid*.

Locality from where reported.—The insect was found forming large galls on the aspens growing at Bunji on the road to Gilgit.

NOTE.—The above descriptions of *Pemphigus napæus* and *P. immunis* are both by Mr. Buckton, an authority on *Aphidæ*.

5. *Ceretaphis* sp.—

Tree attacked.—*Cinchona* (*Cinchona* sp.)

A minute insect which lives on cinchona but has not yet been noticed to do any damage in particular. The larva seems to be blind, whilst the winged insect is well provided with eyes.

Locality from where reported.—The insect was obtained by Mr. Gaminie of the cinchona plantation at Mungphu in Sikkim. The specimens sent were inadequate, and further specimens have been promised to enable the *aphid* to be correctly identified and named. Plate I (2) shows this insect magnified.

6. *Oregma bambusæ*, Buckton.

Buck. Ind. Mus. Notes, Vol. III, p. 87, 108.

Tree attacked.—Kaltung (*Bambusa arundinacea*, Retz.).

Mr. Buckton in describing this insect remarks that hitherto these *homoptera* (*aphidæ*) have been regarded as chiefly inhabiting temperate regions of the world, but there are reasons for believing that observation only is needed to prove the existence of diverse species which control the vegetation flourishing under the equator.

Larva.—The small and larval forms have the two cornua below the vertex much produced as shown in Figure 13 vi. Figure 13



FIG. 13.—*Oregma bambusæ*.

shows (i) alate female insect, (ii) antenna of same, (iii) tarsus and part of tibia, (iv) caudal end, (v) young specimen of larva, (vi) magnified view of head with cornua, etc.

Imago.—The apterous and winged female insects are described below.

Apterous viviparous female.—Body globose, less so in the immature forms. Corrugated and constricted into segments. Vertex with two cornua. Eyes very small. Notum narrow.

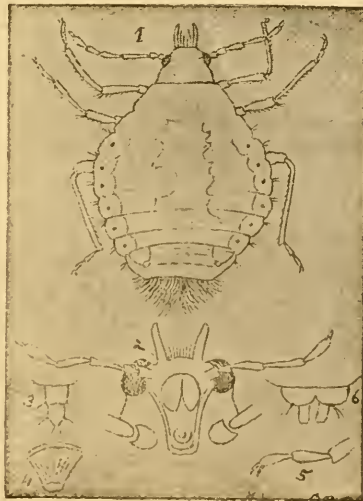


FIG. 14.—*Oregma bambusæ*.

Rostrum very difficult to see, issuing from the under-side of the thorax, much as in *Coccus*. Antennæ about half the length of the body, obscurely five-jointed and ending with a nail-like process. Legs short. Tarsi with two articulations. Colour greenish-brown, more or less mottled with black. Size 0.070×0.050 inch.

The insect clusters on the upper surfaces of the bamboo covering the foliage of the plants with its sooty black excretion, thereby doing some injury. The figure, Fig. 14, shows (1) apterous viviparous ♀; (2) under-side of the head showing position of rostrum between the fore coxæ, the two cornua and antennæ; (3); the two-jointed rostrum; (4) the cornicle; (5) tarsus; (6) abdominal apex of immature forms.

Winged female.—Body wholly black. Head moderate without marked cornua. Eyes obvious, antennæ about one-third the length of the body, five-jointed, the apex minute. The third joint much the longest and more than double the length of the fourth, both these and the fifth joint numerously ringed. Rostrum short. Wings ample, membrane rather fuscous. Cubitus with a marked punctured stigma. Cubical vein once forked and not confluent with the cubitus. Lower wings normal. Caudal end bilobed.

Locality from where reported.—In March 1892 specimens of this insect were forwarded by the Director of the Forest School, Dehra Dun, to the Indian Museum, Calcutta. It was found attacking the leaves of the *Bambusa arundinacea* in the school compound. The insect covered the leaves with a black sticky gum, which was in such quantities that it fell off in drops. From these specimens the apterous ♀ was described by Mr. Buckton. The winged ♀ was described from specimens sent by Mr. Green from Ceylon, where it was found upon 'the cultivated yellow-stemmed bamboo' (name?)

7. *Chermes abietis*, Linn. Spruce-gall aphid.

Buck. Mon. Brit. Aphides, Vol. IV, p. 24.

Tree attacked.—Himalayan spruce fir (*Picea Morinda*, Link. = *Abies Smithiana*, Forbes). This pest was found attacking the spruce in India, and on being sent to Mr. Buckton was determined by him to be identical with the European form, *Chermes abietis*.

The following notes on the life history of this pest in Europe are extracted from a pamphlet¹ by Mr. Walter Blandford, Entomological Lecturer at the Royal Indian Engineering College, Cooper's Hill.

¹ "Insects injurious to coniferæ," by Mr. W. F. H. Blandford, M.A., F.R.H.S., F.Z.S., printed in the *Journal of the Royal Horticultural Society*, Vol. XIY, Conifer Conference Report.

Egg.—A mass of eggs are laid by parthenogenetic females in April at the spot (generally at the junction of two branches) at which they attach themselves.

Larva.—The larvæ when hatched penetrate the surrounding parts of the shoot with their beaks; the shoot swells as do the bases of the needles, and a growth commonly known as a 'Pine-apple gall' or 'Spruce-gall' results. This gall somewhat resembles a small fir cone about an inch long, with the surface divided into small convex areas, each bearing a short needle-like projection in the middle; these are deformed needles, which, becoming swollen, touch each other on the outside of the gall, but which are separate inside, so that the gall contains a series of cavities or chambers. In these cavities the larvæ live in numbers, either entering the chambers during the growth of the gall or being enclosed by the swelling of the surrounding needles; on this point there is a difference of opinion. The galls sometimes completely surround the base of the shoot, sometimes they are only developed on one side. The larvæ are closely packed in the chambers, from 20 to 30 being found in each one. They are full grown in August.

Imago.—When full grown the larvæ acquire wings and leave the chambers by apertures left by the shrinking apart of the leaves.

These insects are winged females, and their special function is that of spreading the species to other trees. They spread over adjacent trees (a certain number of them migrating to the larch), feed as before and lay their eggs, which are covered with a cottony deposit.

The males (which have recently been discovered) appear in the autumn only and pair with the females. From the sexually-produced egg arises the wingless female form (stem mother) who lives through the winter and lays in April the mass of eggs with which this description started.

In Europe there is also a *Chremes* infesting the larch tree (*Larix europæa*, D. C.), and recent researches have shown that the two are alternating forms of one and the same species. The sexual generation occurs at most once a year and always on the spruce, while it is separated from its successor by a series of agamic generations, consisting entirely of female forms which may remain on the spruce or may migrate to the larch, the forms on the latter tree being therefore all agamic.

If the above discovery is correct it will be most interesting to find out the second host plant in India. In Europe the spruce and larch are often planted together, and this favours the insect. If the spruce is pure forest at Chakrata, from where the insect has been reported, it may be found that in India *C. abietis* is able to exist on one host-plant.

Locality from where reported.—In April 1892 some galls found on the spruce fir trees near Chakrata, in the North-West Himalayas, were sent to the Indian Museum, Calcutta, by the Director of the Forest School, Dehra. The insect responsible for the galls proved to be *C. abietis*. In July 1893 further specimens were sent from the North-West Himalayas by Mr. A. Smythies. At Deoban Mr. Smythies observed the emergence of the winged imago on July 21st. In the months of May and June only immature specimens were to be found.

The specimens were identified by Mr. Buckton as *C. abietis*.

The effect of the galls on the tree is to cause crippling of the attacked shoot, and when they are abundant the general growth of the tree is much impaired. Plate IXa shows a gall of *Chermes abietis* on a spruce-twig.

Family III.—*Psyllidæ*.

1. *Psylla cistellata*, Buckton.

Buck. Ind. Mus. Notes, Vol. III, p. 91.

Tree attacked.—Mango (*Mangifera indica*, Linn.).

This insect attacks the mango and causes the terminal shoots of the tree to assume the form of imbricated pseudo-cones of a bright green or yellow colour, thus aborting them. These pseudo-cones were found to contain mature *P. cistellata*. When cut open the cones show a central pillar from which septa or curved walls proceed and form chambers which appear to have free communication one with the other. These cones would be

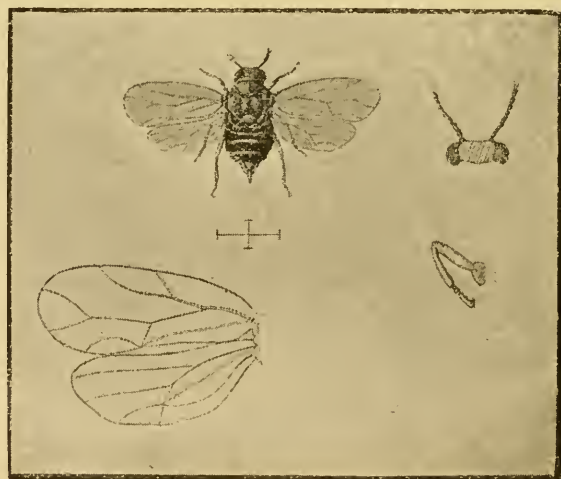


Fig. 15.—*Psylla cistellata*.

formed by the tree under the irritation produced by the larvæ sucking the juices of the branches. When mature, winged insects



FIG. 16.—Mango-twigs with shoots*aborted by *P. cistellata*.

would issue from these cones. Figure 15 shows the winged insect with much enlarged diagrams of the wings, head, and one of the legs. Figure 16 shows the end of a mango-twig with aborted shoots. The size of the insect is indicated by the hair line.

Locality from where reported.—In April 1891 the Director of the Forest School, Dehra, forwarded blighted shoots of mango to the Calcutta Museum, with the information that the whole of the mango trees in a large garden near Dehra were attacked, although strangely enough other trees close by had not suffered. The insect was sent home to Mr. Buckton and determined by him as a new species of the genus *Psylla* which he named *cistellata*.

2. *Phacopteron lentiginosum*, Buckton.

Buck. Ind. Mus. Notes, Vol. III, No. 5, p. 18.

Tree attacked.—Kaikar (*Garuga pinnata*, Roxb.).

Specimens of this insect were forwarded to the Indian Museum in May 1893 by Mr. Marshall Woodrow from Poona.

The insect was found attacking *Garuga pinnata*, galls arising from these attacks. Mr. Buckton, whilst describing and naming the species, stated that the specimens received by him were mildewed from damp, and that more specimens were required to

make his observations complete. Only the winged form of the insect was present.

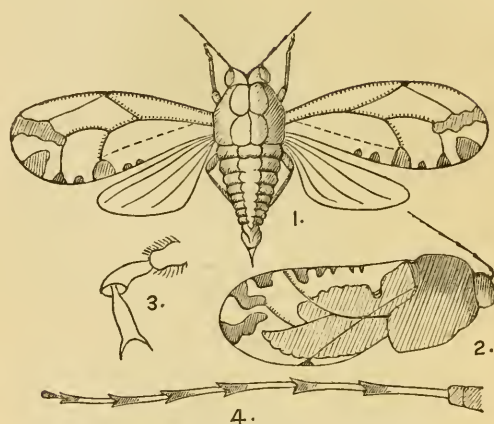


FIG. 17.—*Phacopteron lentiginosum*.

Figure 17 shows (1) the winged female; (2) the insect seen in profile, showing the overhanging pronotum; (3) tarsal joints and claws; (4) antenna.

Family IV.—*Cercopidae*.

1. *Macharota* sp.—

Tree attacked.—Farash (*Tamarix articulata*, Vahl.).

Specimens of cases ("webs") made by a Homopterous insect, probably belonging to the genus *Macharota*, were received from the Deputy Conservator of Forests, Multan. When fresh these webs are elastic and can be pulled out to ten and twelve times their own length without breaking. He stated that it was rather rare on the farash tree and that he could not find it on any other tree nor could he find any insect. The damage done is so far small; the twigs dry up.

Family V.—*Cincadellidae*.

1. *Idiocerus niveosparsus*, Lethiery.

Jour. A. S. B., Calc., 1889, p. 252.

Tree attacked.—Mango (*Mangifera indica*, Linn.).

This pest appears to subsist upon the juices of the flowers, young leaves, and young shoots of the mango.

Imago.—The winged insect is small, dark-coloured and wedge-shaped. It is stated that it cannot fly far, and when disturbed flies out among the leaves for a few seconds and immediately settles upon them again. The insects are found on the mango all the summer, but do most damage when the trees are in flower by damaging the reproductive organs and thus causing interference with the setting of the fruit. Plate I (3) shows this insect.

Locality from where reported.—These insects were reported as attacking mango trees by Mr. Gollan of the Botanical Gardens at Saharanpur. He wrote that “last year (1888?) and the year before we had the pest in myriads, and both these seasons we had light crops of fruit, but this year a fine crop has set, and this I attribute to the comparative absence of these insects.”

The pest was sent to Mr. Lethiery, of Lille, who pronounced it new to science. He discovered that three distinct species of insect had been sent to him and named them respectively *Idiocerus niveosparus*, *I. clypealis* and *I. atkinsonii*.

2. *Idiocerus clypealis*, Lethiery.

Jour. A. S. B., Calc., 1889, p. 252.

Tree attacked.—Mango (*Mangifera indica*, Linn.).

This insect was sent with *I. niveosparus* for identification. It sucks the juices of the flowers, young leaves, and young shoots of the mango.

3. *Idiocerus atkinsonii*, Lethiery.

Jour. A. S. B. Calc., 1889, p. 252.

Tree attacked.—Mango (*Mangifera indica*, Linn.).

This insect was reported to attack the mango in company with *Idiocerus niveosparus* and *I. clypealis*.

HETEROPTERA.

The *Heteroptera* group of the *Hemiptera* injure trees by sucking the juices of the leaves and young branches.

The following trees have been reported as attacked :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
PENTATOMIDÆ .	{ 1. Babul (<i>Acacia arabica</i> , Willd.)	. Bark bored into and drops off.
COREIDÆ .	{ 1. Chilla (<i>Casearia tomentosa</i> , Roxb.)	. Leaf juices sucked.
	{ 1. Chilauni (<i>Schima Wallichii</i> , Choisy)	. Shoots and leaves killed.
CAPSIDÆ .	{ 2. Cinebona (<i>Cinchona</i> sp.)	. Leaf juices sucked.

Family VI.—*Pentatomidæ*.

1. *Genus? species?—*

Tree attacked.—Babul (*Acacia arabica*, Willd.).

Specimens of an insect said to be destructive to the babul tree in the Jerruck forest, Sind, were sent to the Calcutta Museum in December 1895. In connection with them the Deputy Conservator of Forests, Jerruck, Sind, wrote as follows :—

“ I am sending you by post a small insect which I removed from between the bark and wood of a babul tree yesterday morning. This insect evidently does a great deal of damage to babul, judging from its attack on the particular tree. The bark was discoloured and it was commencing to fall off.

“ The larvæ of the insect weave a sort of web in the interstices of the bark, and I presume they subsequently bore into it and make it drop off. ”

The specimens proved to be the immature form of a bug belonging to the family *Pentatomidæ*, the material being insufficient for precise identification. Further specimens are required, as it is extremely doubtful that a *pentatomid* would be guilty of such an attack.

Family VII.—*Coreidæ*.

1. *Scutellera nobilis*, Fabr.—

Lam. Hist. Nat. iii, p. 491 (1816)=Cimex nobilis, Fabr.

Tree attacked.—Chilla (*Casearia tomentosa*, Roxb.).

Specimens of this insect were forwarded to the Indian Museum, Calcutta, by the Director of the Forest School, Dehra Dun, from the forests of the North-West Himalayas. The insect was found feeding on the leaves of the *Casearia tomentosa* at Kalsi on the Chakrata Road, Dehra Dun.

Nothing more seems to have been reported about the pest.

Family VIII.—*Capsidæ*.

Helopeltis theiovora, Moore. ‘ Mosquito Blight ’.

Waterhouse, Trans. Ent. Soc., p. 458, t. XI, f. 3 (1886).

Tree attacked.—Chilauni (*Schima Wallichii*, Choisy.) Tea bushes.

Eggs.—Eggs are laid in the soft and young stems of the new shoots and can be discovered by the three small hairs attached to each which protrude from where each lies. They are $\frac{1}{32}$ inch in length and very slender. When first laid they are hard and white, out become red on hatching.

Larva.—The larva becomes full grown in a week after its emergence from the egg. It has the characteristic bug-like odour of the larvæ of this group. It is about $\frac{1}{16}$ th inch long, obtuse, soft, with a very small clavate caudal appendage, colour amber-hyaline, but after sucking the juices of leaves for some time it becomes greenish in colour. The head is horizontal. Rostrum is $\frac{1}{3}$ rd to $\frac{2}{3}$ ths the length of the body, and in repose lies quiescent on the pectus; two eyes, no ocelli, antennæ purplish, hemelytra rudimentary.

Imago.—The insect gradually increases in size and becomes of a deep amber or orange colour, the antennæ become longer and turn to black, and the insect is less active although furnished with complete hemelytra, which with the head and pronotum are black, whilst there is a broad white band on the abdomen.

In Darjiling District it has been noted that the insect injures the shoots in spring and also in September, but there does not seem to be any fixed time for the appearance of the insect or seasonal broods. The attacked shoots become dry and withered under this insect's operations.



FIG. 18.—*Helopeltis theivora*.

The chief points about the life history to be ascertained are the length of time passed in the various stages of development at different periods of the year, and the method of hibernation during the winter months. A controversy is being waged on the latter point, and various theories have been put forward. One is that the insect hibernates on some jungle plant or plants. Mr. Dudgeon's theory, from whose report on the insect I have

extracted the above notes, is that the insect hibernates in a semi-dormant state near the roots of the tea plant, either in the larval or imago state. When the weather becomes warmer its vigour returns and it recommences feeding. Figure 18 shows diagrams of this insect.

Locality from where reported.—The insect was reported as injuring the chilauni tree in the Darjiling district by Mr. Harcourt. The latter stated that the pest does not ascend above 4,500 feet above sea level.

This insect is the well-known 'Mosquito Blight' which does a large amount of damage in tea gardens. A garden attacked by the insect soon has a brown withered appearance, all the shoots and leaves drying up and dying.

2. *Helopeltis febriculosa*, Begroth.

Ent. Mon., Mag., XXV, 1889, p. 271.

Tree attacked.—Cinchona (*Cinchona* sp.).

This insect is closely allied to *H. theiorora* and may prove to be identical.

It has been reported as attacking cinchona in Sikkim, but is not said to have done much damage.

3. *Disphinctus humeralis*, Walker.

Walker, Cat. Sep. Het., VI, p. 162 (1873).

Tree attacked.—Cinchona (*Cinchona* sp.)

The following is a description of this insect :—

Red, slender, shining, very finely punctured; head short, triangular, eyes black, prominent; rostrum reaching the intermediate coxæ; antennæ black, very slender, first joint picous, rather stout, a little shorter than head; second joint more than thrice as long as first; pronotum contracted in front, with two transverse furrows, and with a large black spot on each side posteriorly; legs luteous, slender, corium and membrane hyaline, brownish cinereous, veins brown.

Locality from where reported.—This insect was discovered in 1888(?) attacking the cinchona plantation at Mungphu in Sikkim. It does not appear to have done much damage. Nothing further concerning its life history seems to have been reported.

NEUROPTERA.

This order is unimportant in Forestry.

CHAPTER III.

COLEOPTERA.

PENTAMERA.

The following is a list of the trees, with the parts attacked, so far reported as suffering from the depredations of the Pentamerous group of beetles :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
LUCANIDE	1. Oak . . . (<i>Quercus</i> sp.)	Wood tunnelled into.
	2. Kharani . . (<i>Symplocos theaefolia</i> , Ham.)	Wood tunnelled into.
	3. Sauer . . . (<i>Betula cylindrostachys</i> , Wall.)	Wood tunnelled into.
	4. Musre katus . (<i>Castanopsis tribuloides</i> , A.D.C.)	Wood tunnelled into.
SCARABEIDÆ	1. Casuarina . . (<i>Casuarina</i> sp.)	Wood tunnelled into (?).
	2. Utis . . . (<i>Alnus nepalensis</i> , D. Don.)	Leaves stripped off.
	3. Coconut . . (<i>Cocos nucifera</i> , Linn.)	Wood and leaf shoots tunnelled into.
	4. Sauer . . . (<i>Betula cylindrostachys</i> , Wall.)	Wood tunnelled into.
BUPRESTIDÆ	1. Sal . . . (<i>Shorea robusta</i> , Gærtn.)	Wood tunnelled into.
	2. Teak . . . (<i>Tectona grandis</i> , Linn.)	Wood tunnelled into.
	3. Khair . . . (<i>Acacia Catechu</i> , Willd.)	Wood tunnelled into.
	4. Mango . . . (<i>Mangifera indica</i> , Linn.)	Wood tunnelled into.
	5. Kaikar . . . (<i>Garuga pinnata</i> , Roxb.)	Wood tunnelled into.
	6. Chir . . . (<i>Pinus longifolia</i> , Roxb.)	Wood tunnelled into.
	7. Poplar . . . (<i>Populus euphratica</i> , Oliv.)	Wood tunnelled into.
BOSTRYCHIDÆ	1. Bahera . . . (<i>Terminalia belerica</i> , Roxb.)	Wood tunnelled into.
	2. Khair . . . (<i>Acacia Catechu</i> , Willd.)	Wood tunnelled into.
	3. Sal . . . (<i>Shorea robusta</i> , Gærtn.)	Wood tunnelled into.
	4. Bamboo . . <i>Bambusa</i> sp.	Wood tunnelled into.
	5. Kail . . . (<i>Pinus excelsa</i> , Wall.)	Shoots, branches and wood attacked.
	6. Gulgoja . . (<i>Pinus Gerardiana</i> , Wall.)	Shoots, branches and wood attacked.

Family I.—*Lucanidae*.

The damage to trees is done by the larvæ tunnelling into the wood.

1. *Lucanus lunifer*, Hope—

Hope in Royle, *Himal. Ins.*, p. 55, t. 9, f. 4.

Tree attacked.—Oak (*Quercus* sp.)

The following is supposed to be the life history of this beetle.

Egg.—The eggs are said to be laid in the bark of trees, probably chiefly in dead and rotting ones.

Larva.—A Lucanid larva has a well marked head, jaws, and antennæ. The head is horny. Legs long and stout. Body soft, white, and fleshy and always bent round on itself, the last segment being swollen in a bag-like manner.

This larva is supposed by Thompson¹ to live some three to four years before transforming into the pupal state. It lives chiefly on rotten wood, and is said to have a partiality for oak.

Thompson in his report makes the following statement :—

“Some idea may be formed of the ravages of these insects when it is stated that the larvæ live from three to four years in that state in the interior of trunks of oaks, and that barely one in ten of the trees to be met with about Nynce-Tal does not bear the marks of their ravages.” (The writer concludes that some of these oaks must have been living, the wood being therefore still hard and good.) “These and larvæ of *Prionus* (a cerambyx ?) beetles seem exclusively to attach themselves to the oak as their habitation. They bore circular chambers, penetrating to the heart of the stem, winding into various passages both up and down the trunk. They eject the undigested particles through holes made for the purpose, forming lateral communications with the main tunnels; these particles may be seen at the roots of the trees so affected in the form of small lengthened chips.”

The writer considers that the greater part of this damage is probably due to the *Prionus* larva, which he gathers from Mr. Thompson's figure of the insect to be a longicorn beetle. Longicorn larvæ with their powerful mandibles, straight body, and power of rapid locomotion during their boring operations, are more likely to destroy sound timber than Lucanid larvæ with their curved bodies and swollen bag-shaped posterior segment. It is probable that the eggs are laid in the rotten wood of trees dying from the attacks of '*Prionus*' larvæ, and the Lucanid larvæ make use of the old tunnels of the former grub, enlarging them to admit the

¹ Report on insects destructive to woods and forests, by Mr. R. Thompson, Assistant Conservator of Forests, 1863.

Several extracts from this Report will be found in later pages of this pamphlet.—E. P. S.

entrance of their sack-like bodies. To a slight extent the larva of *Lucanus lunifer* probably bores into decaying timber, but his progress must necessarily be snail-like, and would be practically nil if the timber it bored into were new and green. Mr. Cotes¹ states that the larvæ are said to live from two to six years, but remarks that no very definite observations seem to have been made on the subject in India.

Pupa.—When full grown, the larva is said to construct a cocoon of chips in the burrow from which the beetle afterwards emerges.

Imago.—*Lucanus lunifer* in its imago stage is a big dark-green coloured beetle, the male being larger than the female and possess-

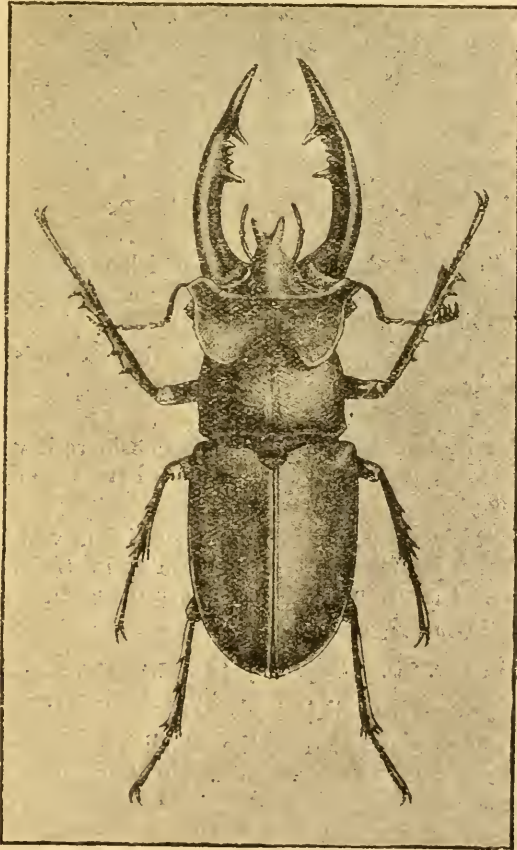


FIG. 19.—*Lucanus lunifer*, ♂.

¹ "An Elementary Manual of Zoology, designed for the use of Forest Officers in India," by E. C. Cotes, late Deputy Superintendent of the Indian Museum, Calcutta.

ing enormously developed mandibles. They can be recognised by their peculiar elbowed antennæ with flattened terminal joints.



FIG. 20.—*Lucanus lunifer*, ♀.

The beetles are said to feed on the sap which exudes from wounds on trees. Figure 19 represents a ♂ beetle, natural size, and Figure 20 a specimen of the ♀, also natural size.

Locality from which reported.—This is thought to be the species described by Mr. Thompson, as above mentioned, as attacking ten per cent. of the oaks in Nynee-Tal.

The writer has already stated that he considers it very improbable that this large percentage of attacked trees could be due to *Lucanid* larvæ.

In the writer's collection is a male specimen which he picked up on 26th February 1896 in the Chel Valley in the east of Darjiling District. Elevation 1,000 feet above sea level.

2. *Lucanus mearesi*, Hope—

Hope, *Proc. Ent. Soc.* 1842, p. 83. *Ann. Nat. Hist.* XII, 4, p. 364.

Tree attacked.—Kharani (*Symplocos theaefolia*, Ham.).

This insect was reported from the Darjiling forests by Mr. C. G. Rogers of the Forest Department. He stated that it bores into the dead sap wood of the kharani tree at elevations of from five to six thousand feet above the sea level.

3. *Lucanus cantor*, Hope—

Hope, *Proc. Ent. Soc.* 1842, p. 83. *Ann. Nat. Hist.*, XII, p. 363.

Trees attacked.—Sauer (*Betula cylindrostachys*), *Muscricatus* (*Castanopsis tribuloides*, A. DC.) and Kharani (*Symplocos theaefolia*, Ham.).

These beetles were found by the writer in considerable numbers in fallen and decaying Sauer, Musre katus and Kharani trees. They were chiefly found in rotten wood, and it was not observed that any sound tree was attacked by them.

Locality from where reported.—The beetles were obtained in the Loolagaon forest, Darjiling District, at an elevation of 5,000 feet, on April 28th, 1896. The writer has since noticed that they are common between 4,500 feet and 6,000 feet.

Imagoes have also been obtained in July at these elevations.

Specimens were sent to the Indian Museum, Calcutta, and determined as *I. cantor*.

The insect has also been found in Jaunsar, North-Western Provinces, at an elevation of 5,000 feet, at the end of April.

Family II.—*Scarabaeidae*.

These insects do damage both in the larval and imago state.

1. *Lachnosterna impressa*, Burm.—Cockchafer.

Burm. Handb., IV, 2, p. 314.

Tree attacked.—Young plants of all kinds.

The life history of this destructive insect has not as yet been properly worked out in India, but from what is known of its confrères in other parts of the world it is probably somewhat as follows:—

Egg.—The eggs are laid by the female in the ground, probably about the beginning of the rainy season in Northern India; but this point requires confirmation.

Larva.—From the eggs emerge small curved white grubs armed with powerful jaws, with which they bite off the roots of plants. These grubs never quit the ground. They moult at intervals and gradually grow bigger until they reach the size shown in Figure 21. They then moult and change into pupæ. The length of time spent in the larval stage is not known, but it is probably a long one. [NOTE.—The European species, *Melolontha vulgaris*, Fabr., spends more than three years¹ in this stage, whilst the American species *Macrodactylus subspinosus*, Fabr., spends the greater part of a year² as a larva.] A number of nearly full grown larvæ sent to the Indian Museum, Calcutta, from Darjiling in October 1891, remained in the earth in the bottom of the breeding cage in which they were kept until the following February, when a beetle emerged. This shows that the cold weather is passed in the ground. This larva is the well-known 'white grub' of tea and coffee gardens.

¹ Ormerod.

² Packard.

Pupa.—The pupal stage is passed in the ground, and it is probable that the insect is in this stage of its life history during



FIG. 21.—*Lachnosterna impressa*.

a portion, at least, of the cold weather. When the imago is ready to emerge the pupal skin splits down the back. The pupal state is shown in Figure 21.

Imago.—The imago is a brown beetle shown, natural size, in Figure 21. The plates of the antennæ are movable. It emerges from the pupal skin in the ground and then makes its way out. The beetle flies about for a time and perhaps eats a few leaves. The writer has seen them in the Darjiling forests on the wing from the end of March, through April, into May. During these months they mate and probably lay their eggs in the ground.

Locality from where reported.—In 1891 *L. impressa* appeared in vast quantities in some of the Darjiling tea gardens and made great havoc amongst the young tea plants. In 1883 it did great damage to the public gardens, Darjiling, where some 2,695,000 individuals were destroyed. In neither of these cases can any mention of their action in the forest be found, although it would seem only too probable that young seedlings in nurseries, etc., must have suffered considerably.

2. *Genus ? species ?*—

Tree attacked.—*Casuarina* (*Casuarina* sp.).

Some large curved grubs said to bore into the heart of *Casuarina* trees and thus affect their growth, were forwarded

through the Director of the Forest School, Dehra Dun, from the District Forest Officer, Chingleput. These larvæ proved to be Coleopterous and apparently belonged to the sub-family *Melolonthini*. Further specimens of the pest are necessary for identification, it being considered extremely doubtful that the larvæ of the sub-family are able to injure trees in this way.

3. *Anomala viridis*, Fabr.—

Fabr. Syst. Ent., p. 34; *Burm. Handb.*, IV, 1, p. 275.

Tree attacked.—*Utis* (*Alnus nepalensis*, D. Don.).

This insect was reported from the Darjiling forests by Mr. C. G. Rogers, Deputy Conservator of Forests. It is stated to strip the leaves off the utis tree growing at elevations of from five to six thousand feet above sea level. The damage was noticed to take place in June.

4. *Oryctes rhinoceros*,¹ Linn.—‘Rhinoceros beetle.’

Linn. Syst. Nat., ed. XI, p. 346, ed. XII, I, 2, p. 544.

Tree attacked.—Cocoanut (*Cocos nucifera*, Linn.).

This is a large black or brown beetle with a protuberance like the immature horn of a rhinoceros on the upper part of its head. It is very injurious to palm trees, especially the cocoanut palm. The damage is done to the tree by the insect cutting large holes through the young leaf shoots. The following is an extract from a letter on this subject received in the Indian Museum, Calcutta :—

“This beetle is very common in Kanara and does much mischief to cocoanut trees. It attacks the trees at the growing point and burrows downwards. In doing this it eats through the folded young fronds, so that, when they expand, they appear to have been cut in regular patterns.”

It is stated, in another account, that if a beetle effects a permanent lodgment in the heart of a tree, that tree will die.

Locality from where reported.—The insect has been reported as extremely destructive in Madras and Singapore. It has also been noticed in Calcutta.

5. *Genus? sp.?*

Tree attacked.—Sauer (*Betula cylindrostachys*, Wall.).

This insect was found in the mature state in a decaying Sauer log. It was forwarded to the Indian Museum, Calcutta, for identification, but proved to be new to the Museum collection.

Locality from where reported.—The beetle was found by the writer in a decaying Sauer log in the Loolagaon forest, Darjiling District, in April 1896, at an elevation of 5,000 feet above sea level.

¹ This insect is mentioned in a pamphlet entitled “Destruction of cocoanut palms by beetles,” by Mr. Ridley. Government Press, Singapore, 1889.

Family III.—*Buprestidae*.

In this family the injury is done in the larval state of the insect, the larvæ tunnelling into the wood.

1. *Chrysobothris sexnotata*, Gory.

Gory. *Monogr. des Buprestides*, IV, p. 159, t. 27, fig. 154.

Tree attacked.—Sal (*Shorea robusta*, Gærtn.).

Egg.—It is believed that the eggs are laid in fissures of the bark of the tree attacked. The time of laying and the length of the egg stage has not yet been noted.

Larva.—According to Thompson “the larva, after acquiring maturity, bores into the timber to the depth of from two to three inches, making a diamond-shaped orifice”.

Pupa.—According to the above mentioned author the larva changes into the pupal state in the diamond-shaped orifice.

Imago.—This is a prettily-coloured beetle, and is thought to be the one reported by Thompson as found by himself in fallen sâl



FIG. 22.—*Chrysobothris sexnotata*.

logs. The insect sometimes infests the tree in vast numbers, rendering the timber unfit for use afterwards. Apparently it is only dead and dying trees that are affected in this way. Thus ringing sâl trees several years before they are felled (so as to render them lighter for floating and transport purposes) is a dangerous practice, the timber being rendered liable to attacks by these insects. Figure 22 represents an imago of *C. sexnotata*.

Locality from which reported.—*C. sexnotata* is thought to be the insect reported by Mr. Thompson as attacking felled sâl logs in the Kotree Dun, North-West Provinces, in 1860.

2. *Psiloptera fastuosa*, Fabricius.

Fabr. *Syst. Ent.*, p. 216; Cast. et Gory. *Monogr. I*, p. 84, t. 22, fig. 114.

Tree attacked.—Teak (*Tectona grandis*, Linn.).

Specimens of this beetle were forwarded through the Madras Museum to the Indian Museum, Calcutta



FIG. 23.—*Psiloptera fastuosa*.

They were reported to injure the Government Teak Plantations at Nilambar, Malabar, by boring into the wood.

Nothing seems to have been recorded on the habits of this pest. Figure 23 represents a dorsal view of the insect, natural size.

3. *Belionota scutellaris*, Fabr.

Fabr. Syst. El. II., p. 203; Cast. et Gory. Monogr., II, p. 4, t. 1, fig. 2.

Tree attacked.—Khair (*Acacia catechu*, Willd.).

This is stated by Mr. Thompson to be a very handsome beetle.

The specimen obtained was found by him in the dead branch of a living khair tree, and the death of the limb is stated to have been due to larvæ of this insect.

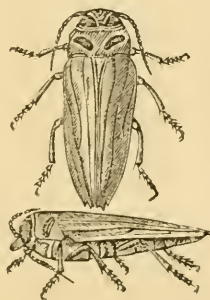


FIG. 24.—*Belionota scutellaris*.

Locality from where reported.—Reported from the Dun forests, North-West Provinces, by Mr. Thompson in 1868.

Figure 24 shows a dorsal and side view of an imago of *B. scutellaris*, natural size.

4. Undetermined *Buprestidae*.

Three other species of *Buprestidae* have been reported as tunnelling into the wood of trees, but very little else seems to be known about them and they are as yet unclassified.

- (a) A large species, of which a larva was found tunnelling into the mango (*Mangifera indica*) tree in the Dun (Thompson). A similar larva was found by the writer tunnelling into the *Garuga pinnata* tree in the Terai forests in the Darjiling District. An attempt was made to obtain the imago from it, but it was not successful, as the larva died.
- (b) A small species of a shining olive colour with yellowish white spots is said to attack chir (*Pinus longifolia*) wood, sometimes rendering it unfit for beams (Thompson).
- (c) A species was sent to the Museum at Calcutta from Baluchistan, said to have been found boring into the poplar (? *Populus euphratica*) tree.

Family IV.—*Elateridae*—Click Beetles.

This family has not yet been reported as doing damage in our Indian forests. Mr. Cotes in his Manual of Zoology makes the following remark :—

“As yet they (*Elateridae*) have only been reported as injurious to potato plants in India, but considering how much damage they do to other plants in Europe and America, these pests are ones that should be noticed” (by Forest Officers).

It is in the larval state that they do the damage, the worm (well known as the ‘wire worm’ in Europe) feeding on the roots of plants. Immense damage is done to forest nurseries in Europe by this wire-worm pest, the larvæ moving down the lines in which the young seedlings are planted and cutting through the roots beneath the ground. With reference to such attacks it is worth noting that in the *Indian Forester*¹ Sir D. Brandis mentions, in a note, that although damage by insects has not yet made itself greatly felt by Forest Officers in India, indications are not wanting that the change which systematic forest management must necessarily introduce into the conditions of forest vegetation will facilitate the development of insects injurious to trees and timber.

1. *Melanotus fuscus*, Fabr.

Fabr. Syst., ed. II, p. 228; Cand. Mon. El. III, p. 335.

Some specimens of this *Elater* were sent to the Indian Museum by the writer in July 1896. They were found in rotten wood in

¹ *Indian Forester*, Vol. IX, p. 236.

the Darjiling forests. Elaterid larvæ are often found in such places, but probably do no damage to wood. The larvæ of *M. fuscus* are carnivorous.

Family V.—*Bostrychidæ*.

The chief damage done to trees by this family of beetles is caused by the imago tunnelling into the wood.

1. *Sinoxylon* sp.—

Trees attacked.—*Terminalia belerica*, Roxb., *Acacia ca'cchu*, Willd., Sâl (*Shorea robusta*, Gærtn.).

The precise identification of this insect has not as yet been ascertained, but Dr. Günther of the British Museum has placed it in this genus.

It was at the time of its submissal unnamed in the British Museum.

Egg.—This stage does not seem to have been noted.

Larva.—The larva lives either in the bark of trees or in dead and rotting wood.

Pupa.—This stage has not been noticed.

Imago.—This is a small *Bostrychid* beetle of about a quarter of an inch in length. The figure, Fig. 25, shows the insect enlarged

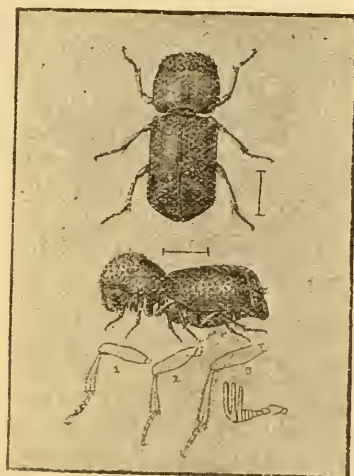


FIG. 25.—*Sinoxylon* sp.

and gives magnified diagrams of the antennæ and first, second and third pair of legs respectively. The beetle is cylindrical in shape and tunnels into and often riddles wood.

Locality from where reported.—Specimens of *Sinoxylon* were forwarded to the Indian Museum, Calcutta, by Mr. Gleadow of the Forest Department in February 1891. He reported that it infested the *Terminalia belerica* tree in the Thana district, Bombay. In July 1893 specimens were forwarded through the Imperial Forest School, Dehra. The beetle was found tunnelling into the sap wood of *Acacia catechu*.

In August 1894 some specimens of this Bostrychid beetle were sent to the Indian Museum, Calcutta, by Mr. A. Smythies, officiating Conservator of Forests, Shillong, with the information that they were found boring into tea box planks at Tezpur, where they are locally called 'Ghoong.'

2. *Sinoxylon anale*, Lesne.

Tree attacked.—Sâl (*Shorea robusta*).

In June 1897 the writer sent some specimens, obtained from dead sâl logs and beams in the Singbhum reserved forests in Chota Nagpur, to the Indian Museum for identification.

These beetles do damage by boring into the beams, rafters, and other supports of the wooden forest rest-houses in Singbhum. These houses are built almost entirely of sâl wood, and the beetles may be heard at work boring in the wood from March on into the rains, whilst tables, chairs, and floors become covered with particles of saw-dust dropping from the roof above. The writer noticed that most of this work was done in the early morning, evening, and during the night. During the heat of the day the boring sounds almost entirely ceased. These beetles were identified in the Indian Museum as a species of *Sinoxylon* unnamed in the Museum accompanied by *Bostrychus jesuita*, Fabr., mentioned below. Both these beetles were found by the writer on the wing and at work during the same period of time. The *Sinoxylon* was very kindly identified for me by Mr. W. F. H. Blandford as *S. anale* of the British Museum Collection.

It is also found attacking sickly sâl trees in the forest.

3. *Bostrychus jesuita*, Fabr.—

Fabr. Ent. Syst., 1, 2, p. 361.

Tree attacked.—Sâl (*Shorea robusta*, Gærtn.).

As mentioned above this insect attacks dead sâl logs and beams, etc., in the Singbhum sâl forests. Both in 1896 and 1897 the writer noticed them to be very plentiful, probably owing to some large departmental sleeper-cutting operations that were undertaken during these years in those forests. Its life history has not as yet been worked out.

4. *Dinoderus* sp.—Bamboo-borer.

Tree attacked.—Bamboos.

This insect was submitted to Dr. Günther, who has reported that it is unrepresented in the British Museum.

Egg.—The eggs are laid in the outer layer of the wood of bamboos.

Larva.—The larva is a small white grub, somewhat curved, with six legs.

Pupa.—The pupal stage does not seem to have been noticed.

Imago.—The beetle is brown in colour and small. It is cylindrical with a hood-like thorax, which is covered in front with flat

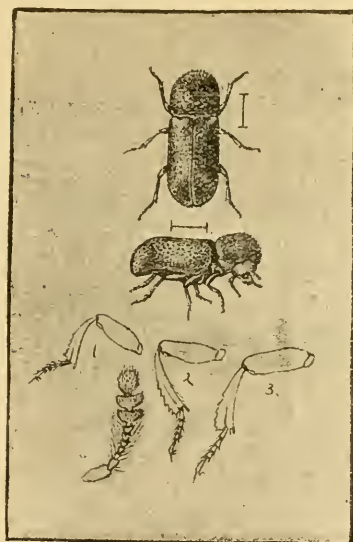


FIG. 26.—*Dinoderus* sp.

projections like a rasp. The serrate antennæ are not angled as in bark beetles. Figure 26 shows the imago enlarged, also much magnified diagrams of the antennæ and first, second, and third pairs of legs, numbered 1, 2, and 3 respectively.

The following is an extract from a letter received by the Indian Museum authorities, Calcutta, from Mr. G. Anderson of Munzerabad, Mysore:—

“This class destroys bamboos, watties (basket reeds), and many jungle woods. The natives have a superstition that no jungle poles or bamboos should be cut when the moon is full, as they argue that the sap is then very abundant, and unless the bamboos are well soaked in a tank and well preserved with plenty of smoke they will be rapidly destroyed by the ‘cootee’ (native name of insect) and other borers”

The following is an extract from Indian Museum Notes¹ on this subject :—

“It may be observed that all the substances which Mr. Anderson mentions are not likely to be attacked by the same species, though they may be attacked by species which are very nearly allied to each other. The idea which prevails with regard to the effect of the moon is a curious one, and would really seem to have some foundation of fact to rest upon, the writer having been told that it prevails generally both in Behar and in the North-West.

“About the only explanation that has been put forward is to the effect that the ‘cootee’, like most other wood-boring insects, prefers to lay its eggs in wood which has commenced to wither and which consequently has no longer a healthy flow of sap to interfere with the insect in its burrow If this is so, the time immediately after the bamboo has been cut down would be the most likely one for it to be attacked This explanation, however, requires confirmation.

“It seems to be the generally received idea that soaking bamboos, and also other timber, in water for a considerable time, immediately after it has been felled, makes it less liable than it otherwise would be to suffer from boring beetles of all kinds. It is supposed that not only does the water prevent the beetles laying their eggs during the time the wood is immersed in it, but that it also drowns the insects already at work and dissolves much of the nutritive matter on which they would otherwise feed.”

That bamboos, once sickly and dying or dead, suffer largely from the attacks of small beetles must be obvious to the most superficial observer who glances over a bamboo clump. The stems will be found riddled with minute holes, the work of these insects. As a sequence to these attacks it follows that bamboos that might have served some useful purposes are destroyed. Writing for Bengal, when bamboos are sold from a forest the purchaser collects a certain number together in one spot, cut from clumps scattered over the adjacent forest, so as to facilitate the checking of the number cut with the permit before they leave the forests. Thus these bamboos, after being cut, remain for a few days in the forest. The writer has noticed that they are, where possible, collected in some nullah containing water in which the bamboos are submerged. This preserves them both from drying up and from boring-insect attacks. This procedure has been noticed in the Singbhum, Darjiling, and Chittagong districts.

Locality from where reported.—It is considered probable that the insect is common to all parts of India where bamboos grow.

It has been reported from Mysore by Mr. G. Anderson and

¹ Vol. I, No. 1, page 44.

from Dehra Dun, where it was obtained by Mr. R. D. Oldham from a tent pole which it had completely destroyed.

NOTE.—In the *Indian Forester*,¹ under the heading “Notes on Insect ravages in Pine Forests,” there is an article signed G. G. M. The insects alluded to are unmistakably *Bostrychid*, and are probably species of *Sinoxylon* or allied genera. The following are extracts from the note :—

“The study and prevention of disease in forest trees is of such great importance, and so intimately connected with the prosperity of forests, that a few notes on a disease in the form of a pest of insects which has done extensive injury in many of the pine forests under my charge in the Sutlej Valley (Bashahr), may be of interest.

“The pest to which my notes refer, made its appearance during the summer of 1882 and spread at an alarming rate over large areas. Young, vigorous trees invariably shook it off, but less hardy ones were either rapidly killed, or after lingering for some time died out. The leaves of infected pines turned an unhealthy yellowish colour, and the branches dried and curled up into claws, giving a most wretched appearance. At the end of the rains the disease abated, and to all seeming disappeared, and for four years the forests were free from its ravages. But in June 1887 it returned, and this time attacked both the *Pinus excelsa* and *Pinus Gerardiana*. In July I noticed that the leaves of the affected trees were beginning to change colour, and that the insect had prepared for first operations the ends of branches and that it had tunneled out between the bark and the sap wood longitudinal galleries, which, on close inspection, I found to contain larvæ and weevils. I continued to observe these during the rains, . . . ; later on when no more larvæ remained the perfect insect abandoned the tender shoots for larger branches, through which it worked holes as far as the heart-wood, and in the direction of the axis of the stem. Branches thus attacked were tattooed all over and did not survive long. This destructive insect . . . is one-tenth inch in length with dull brown coloured elytra, and its larva is a small white grub of the same length . . . Its duration of activity is three months, which is as long as the rains last, for at the end of September its depredations ceased and in October I had difficulty in finding any beetles alive. But doubtless they leave behind in dead wood ample deposits of eggs, which are hatched on some favourable atmospheric change occurring.

“At Changa Manga (a plantation)’ in 1875-76 after large thinning operations the ground was littered with refuse of wood, and a similar pest occurred.”

HETEROMERA.

This group is unimportant. Trees, etc., attacked are—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
CANTHARIDÆ .	1. <i>Lonicera angustifolia</i> , W. and <i>L. quinquelocularis</i> , Hardw.	Leaves eaten.
TENEBRIONIDÆ	2. Sandal-wood (<i>Santalum album</i> Linn.).	Stems bored into.

Family VI.—*Cantharidæ*.—Blister Beetles.

1. *Cantharis antennalis*.—Maiseul.

Tree attacked.—*Lonicera angustifolia*, W. and *L. quinquelocularis*, Hardwicke.

¹ *Indian Forester*, Vol. XIV, April 1888.

Specimens of this insect were forwarded in July 1893 to the Indian Museum, Calcutta, by the Director of the Forest School, Dehra Dun, from the forests of the North-West Himalayas. The beetle was found eating the leaves of *Lonicera angustifolia* and *L. quinquelocularis*. The insects were taken on the 16th June at Deoban, North-West Himalayas.

2. *Mylabris* sp.—

Tree attacked.—Has been reported as defoliating trees.

This insect has been reported as doing a little damage in India as a defoliator. The species of trees which it attacks do not seem to have been noted, but the damage is not likely to be of much practical importance.

This beetle is easily recognisable, the elytra being banded with black and yellow stripes.

Family VII.—*Tenebrionidæ*.

This family has been reported as boring into the stems of sandal-wood (*Santalum album*, Linn.).

1. Obscure *Tenebrionid* larvæ have been reported from Mysore as damaging sandal-wood by boring into the stems. Nothing more seems to have been noted as regards this pest, but it is extremely doubtful that the sandal-wood can be so attacked by *Tenebrionid* larvæ, and more information and observations are required on the subject.

TETRAMERA.

The following list shows the trees that have been reported as suffering from attacks of Tetramerous coleoptera:—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
BRUCHIDÆ	{ 1. Tamarind (<i>Tamarindus indica</i> , Linn.).	Defoliation.
CHRYSOMELIDÆ	{ 1. Willow (<i>Salix elegans</i>).	Do.
	{ 2. Bamboo (<i>Dendrocalamus</i> sp.).	Top shoots destroyed.
	{ 3. Shivan tree (<i>Gmelina arborea</i> , Roxb.).	Defoliation.
CURCULIONIDÆ	{ 1. Coconut (<i>Cocos nucifera</i> , Linn.).	Trunk tunnelled into.
	{ 2. Date-palm (<i>Phoenix dactylifera</i> , Linn.).	Do. do.
	{ 3. Bamboo (<i>Dendrocalamus Hamiltonii</i> , Nees et Arnot).	Growing shoots attacked.
	{ 4. Mango (<i>Mangifera indica</i> , Linn.).	Flower and fruit tunnelled into.

CURCULIONIDÆ	5. Chir (<i>Pinus longifolia</i> , Roxb.).	Wood tunnelled into.
	6. Dhak (<i>Butea frondosa</i> , Roxb.).	Do. do.
	7. Mahogany (<i>Swietenia Mahogani</i> , Linn.).	Do. do.
	8. Sal (<i>Shorea robusta</i> , Gærtn.).	Seed destroyed.
	9. Oak, Bara Katns (<i>Quercus pachyphylla</i> , Kurz.).	Do. do.
	10. Būk (<i>Quercus lamellosa</i> , Sm.).	Do. do.
	11. Kadam (<i>Anthocephalus cadambe</i> , Mig.).	Wood tunnelled into.
	12. Safed Siris (<i>Albizzia procera</i> , Bth.).	Do. do.
	1. Oak, Rīn (<i>Quercus incana</i> , Roxb.).	Do. do.
	2. Oak (<i>Quercus</i> sp.).	Do. do.
	3. Kail (<i>Pinus excelsa</i> , Wall.)	Wood tunnelled into and terminal shoots attacked.
SCOLYTIDÆ	4. Dingsa (<i>Pinus Kasya</i> , Royle).	Wood tunnelled into.
	5. Sal (<i>Shorea robusta</i> , Gærtn.).	Do. do.
	6. Galgoja (<i>Pinus Gerardiana</i> , Wall.).	Wood tunnelled into and terminal shoots attacked.
	7. Chir (<i>Pinus longifolia</i> , Roxb.).	Wood tunnelled into.
	1. Sal (<i>Shorea robusta</i> , Gærtn.).	Young shoots 'ringed' and wood tunnelled into.
	2. Fābul (<i>Acacia arabica</i> , Willd.).	Root and stem tunnelled into.
	3. Amara, Hogplm (<i>Spondias mangifera</i> Willd.).	Wood tunnelled into.
CERAMBYCIDÆ	4. Jhingan (<i>Odina wodier</i> , Roxb.).	Do. do.
	5. Dhak (<i>Butea frondosa</i> , Roxb.).	Do. do.
	6. Semul (<i>Bombax malabaricum</i> , D C.).	Do. do.
	7. Saj, Asan (<i>Terminalia tomentosa</i> , W. & A.).	Do. do.
	8. Teak (<i>Tectona grandis</i> , Linn.).	Do. do.
	9. Farash (<i>Tamarix articulata</i> , Vahl.).	Do. do.
	10. Khair (<i>Acacia catechu</i> , Willd.).	Do. do.
	11. Cooanūt (<i>Cocos nucifera</i> , Linn.).	Do. do.
	12. Wild willow, Baishi (<i>Salix tetrasperma</i> , Roxb.).	Do. do.

CERAMEYCIDE	{	13. Semul (<i>Bombax</i> sp.)	Wood tunnelled into.
		14. Sanjna (<i>Moringa ptery-</i> <i>gosperma</i> , Gærth.).	Do. do.
		15. Roongra (<i>Erythrina sube-</i> <i>rosa</i> , Roxb.).	Do. do.
		16. (<i>Tabernaemontana</i> sp.)	Branches ringed.
		17. Dudhi (<i>Wrightia tinctoria</i> , R. Br.).	Do. do
		18. Sauer (<i>Betula cylindrost-</i> <i>chus</i> , Wall.).	Do. do.
		19. <i>Robinia</i> sp.	Seedlings attacked.
		20. <i>Albizzia</i> sp.	Do. do.

Family VIII.—*Bruchidae*.

The larvæ of this family tunnel into the seed of trees thereby destroying it.

1. *Bruchus chinensis*, Linn.—

Syst. nat. ed. X, p. 386.

Tree attacked.—These insects attack the seeds of leguminous trees.

Egg.—Is probably laid on the stigma of the flower or on the pods before they reach maturity.

Larva.—Are small white grubs. They live in the seeds contained in the leguminous pod.

Pupa.—This stage is passed probably within the pod.

Imago.—The imago is a small brown beetle. When mature, it



FIG. 27.—*Bruchus chinensis*.

bores its way out of the leguminous pod leaving a small round hole in the pod surface. Figure 27 shows the imago with the seeds of various leguminous plants it attacks. Natural size is shown by a hair line.

Locality from where reported.—It has not been reported as damaging the seed of forest trees up to date. The beetle's range is likely to be wide-spread, and for this reason it is alluded to here as a possible pest.

NOTE.—It is possible that this insect may have to be put into the genus *Caryoborus*, as it is doubtful whether any species of *Bruchus* feed on tree pods.

2. *Caryoborus gonagra*, Fabr.—*Fabr. Ent. Syst. Suppl., p. 159.**Tree attacked.*—Tamarind (*Tamarindus indica*, Linn.).

The following notes upon this insect are taken from a paper by H. L. Elditt.¹ He found the insect in the three stages of larva, pupa, and imago in pods of *Cassia fistula* (the Indian Laburnum) which he obtained from apothecaries' shops in Königsberg.

Egg.—With regard to the egg-laying he was not able to make any observation, but concluded the insect was likely to have the same habits as the European *Bruchus pisi*. It would therefore lay its eggs on the pods before they reach maturity.

Larva.—Elditt found that the larvæ, which are small white legless grubs, made their way through the pod and tunnelled directly into the seed. It was found that none of the seeds were attacked by more than one grub and therefore it would seem that the beetle lays one egg on each pod.

Pupa.—When full fed the grub left the seed and spun a close matted cocoon for itself inside the pod. In this the pupal stage is passed.

Imago.—The beetle, which is brown and about the size of a pea, after emerging from the pupal skin rested for a considerable time before cutting its way through the cocoon and the wall of the pod, both of which have to be perforated before it can make its escape. This rest is probably due to the change of temperature consequent on the change from a tropical climate to a colder one. Figure 28 shows the imago.

FIG. 28.—*Caryoborus gonagra*.

¹ "Die metamorphosen des *Caryoborus* (*Bruchus*) *gonagra* F.," by H. L. Elditt. Königsberg, 1860.

Locality from where reported.—*C. gonagra*, in different stages of development, was sent by the Secretary of the Agri-Horticultural Society of India in July 1891 to the Indian Museum, Calcutta, with the report that it attacked the seed of the Tamarind tree in Calcutta.

Mons. A. Fauvel, to whom it was submitted for identification, reported it to be *C. gonagra*. The figure shows the various stages of the insect. Also much enlarged diagrams of the antenna and one of the legs of the imago. Size of insect is indicated by hair lines.

Family IX.—*Chrysomelidæ*.

Injury is done by this family in the imago or perfect state when it feeds on the leaves of trees.

1. *Estigmena chinensis*, Hope—

Tree attacked.—Bamboo (*Dendrocalamus* sp.)

In November 1892 the officiating Conservator of Forests, Hyderabad Assigned Districts, reported that considerable damage had been done in the Melghat forest by a boring insect which destroyed the tops of bamboo (*Dendrocalamus*) shoots, thereby arresting their growth.

Specimens of the pest were determined in the Indian Museum, Calcutta, as *E. chinensis*.

Injured bamboo shoots were afterwards forwarded. The thicker portions of the stem were tunnelled, but this did not seem to be sufficient to account for the death of the bamboo, and a subsequent report seemed to confirm the idea that the damage to and death of the shoots was chiefly due to the eating away of their tops by this chrysomelid.

2. *Melasoma* sp.—

Tree attacked.—Willow (*Salix elegans*).

The following is taken from a series of rough notes made by Mr. C. G. Rogers, Deputy Conservator of Forests, on this insect :—

Egg.—Does not seem to have been noticed.

Larva.—The larvæ were first noticed on 9th June 1893 in Deoban, 9,000 feet above sea level, in the North-West Himalayas. They ranged from 0·10 inch to 0·51 inch in length. The head was black, the body yellowish-white with black markings. On the back were numerous paired glands from which little transparent globules of strong pungent-smelling fluid exuded when the insect was touched. After a while the globules were drawn in again into the glands, but could be again extruded two or three times over before the insect became exhausted. The odour, which is compared to prussic acid, scented the whole bush where they were feeding,

and was a very characteristic feature of the insect. The larvæ which were kept in captivity moulted but once before pupating.

Pupa.—The pupæ were formed between the 14th and 21st of June. The chrysalis had much the same general markings as the larvæ. It remained partially enclosed in the larval skin. In nature the pupæ were found suspended from the under surface of leaves and branches of the food plant.

Imago.—Beetles began to emerge on 22nd June and continued to appear in the rearing box until 27th June. They afterwards lived for about a week in confinement, but as in this period they were carried down to Dehra Dun, elevation 2,100 feet, their ordinary period of existence in this stage is probably longer. They were affected by a Dipterous parasite.

Locality from where reported.—Specimens of this *Chrysomelid* beetle found by Mr. C. G. Rogers in Deoban, North-West Provinces, also a *Tachnid* fly, parasitic on it, were forwarded in July 1893 by the Director of the Imperial Forest School, Dehra Dun, to the Indian Museum, Calcutta. The chrysomelid proved to be unnamed in the Museum, but a careful comparison of it with Olivier's description of *Melasoma populi*, Linn., which has been recorded as feeding on willow trees in Europe, did not disclose any appreciable difference between the two forms, and the Museum authority therefore looks upon it as this species. This superficial comparison is not sufficient, and more specimens are required in order that the insect may be properly identified in the British Museum. It may prove to belong to a new genus.

3. *Calopepla leayana*, Latr.—

Latr. Gen. Creest et Jus. III, p. 50, t. 11, fig. 7.

Tree attacked.—Shivan tree (*Gmelina arborea*, Roxb.).

In September 1893 specimens of this beetle were forwarded to the Indian Museum by Mr. F. Gleadow from Poona. He reported that it cut unsightly holes in the leaves of the Shivan tree. The imago is a small black beetle with red markings. The damage done has not been noticed to be very great.

Family X.—*Curculionidæ*.

This family of beetles comprises a very large number of species, many of which are capable of doing a vast amount of damage to forest trees. The damage is chiefly done by the larvæ of the beetles, which tunnel into the heart of the trees and also attack the seed of some species. It is very probable that there is much to learn about the operations of *Curculionidæ* in Indian forests and that the few attacks reported to date are merely isolated instances of what goes on, as yet undetected, in connection with other forest trees.

1. *Rhynchophorus ferrugineus*, Oliv.—Palm Weevil.

Ol. Encycl. Méth. V., p. 473 ; Ent. V. 83., p. 79, t. 2, fig. 16d.

Tree attacked.—Cocoanut (*Cocos nucifera*, L.). Date palm (*Phoenix dactylifera*, L.) and other palms.

The following is from a report on this insect by Mr. Ridley.¹

Egg.—The egg is generally laid at the base of the leaf stalk, though the insect also takes advantage of any mechanical injury to the stem, or of holes drilled by the Rhinoceros beetle (*Oryctes rhinoceros*) for depositing its eggs.

Larva.—The larvæ shown in Figure 29, which are white, fleshy, legless grubs, tunnel their way through the heart of the trunk and often kill the tree outright. When a tree is attacked there is a



FIG. 29.—Larva of *R. ferrugineus*.

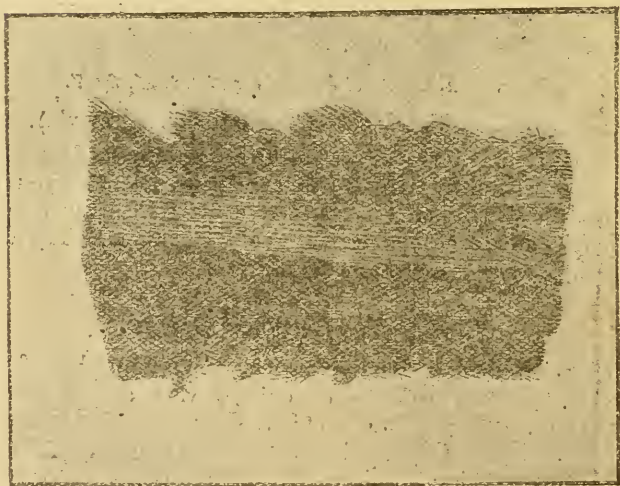


FIG. 30.—Wood tunnelled by *R. ferrugineus*.

¹ "Destruction of Cocoanut palms by Beetles," Government Press, Singapore, 1889.

See also Flandford, "The Palm Weevil in British Honduras," Kew Bull., 1893, pp. 27 to 60.

fætid oozing from the outer trunk, which withers and dies. When cut down and opened out the larvæ are found in masses showing few signs of activity. Figure 30 shows a block of date palm from Lucknow, one-sixth natural size, tunnelled by the larvæ.

Pupa.—The pupa is formed in a cocoon of palm fibre in the burrow. Figures 31 and 32 show cocoon and pupa.



FIG. 31.—Cocoon of *R. ferrugineus*.



FIG. 32.—Pupa of *R. ferrugineus*.

Imago.—The beetles, which in this family can be easily recognised by having the front of the head produced into a proboscis furnished with a pair of elbowed antennæ, fly chiefly at night and are often found in the daytime concealed in the holes of the

Rhinoceros beetle. Figure 33 shows the beetle and Figure 34 side views of the head of the male and female to illustrate the difference in the snout of the two sexes.



FIG. 33.—Imago of *R. ferrugineus*.

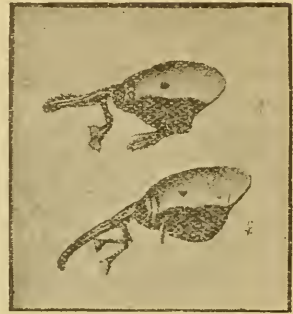


FIG. 34.—Side views of head of ♂ and ♀ of *R. ferrugineus*.

Locality from where reported.—Specimens of this beetle in various stages of development were forwarded to the Indian Museum from Lucknow by the Superintendent of the Government Horticultural Gardens there. The insect was found to attack the stems of the date palm. The Superintendent wrote as follows :—

“The tree from which these were taken blew down a few days ago. At the base, and for half the height of the stem, it was quite decayed and full of the refuse created by the larvæ of the beetle. The upper part was fresh and the leaves green, and until the tree came down it was not noticed to be in a bad condition. On examination a number of other trees were found to be similarly affected, and will no doubt fade before long.”

In October the same insect, both in the grub and beetle stage, was found by Mr. Gollan in the stems of date palms in the Saharanpur Botanical Gardens. According to Mr. Ridley this insect attacks both healthy and unhealthy trees, the latter being

the ones usually preferred by weevils, the flow of sap in the tree being less strong.



FIG. 35.—Cocoanut estate attacked by *R. ferrugineus*.

Figure 35 from Mr. Ridley's report shows the dilapidated appearance which a cocoanut estate presents when suffering from the attacks of the beetles *Rhynchophorus ferrugineus* and *Oryctes rhinoceros*.

2. *Cyrtotrachelus dur*, Behern.—

Boh. in Schönk. Gen. Curc., VIII 2, p. 221.

Tree attacked.—Hill Bamboo (*Dendrocalamus Hamiltonii*, Nees et Arnot).

This is a large brown swift flying *Curculionid* beetle, having in the male enormously developed front legs.

The beetle was reported to the Indian Museum, Calcutta, by Mr. C. G. Rogers, of the Forest Service, from the Darjeeling forests. Mr. Rogers stated that it attacks the asparagus-like shoots of the hill bamboo. It is often found clinging to these shoots, which are perforated by a hole from which it has emerged. Shoots thus attacked come to nothing.

3. *Cryptorrhynchus mangiferae*, Fabr.—

Fabr. Syst. Ent., p. 139.

Tree attacked.—Mango (*Mangifera indica*, Linn.),

The following notes are extracted from a paper by Mr. W. J. Simmons¹ on this insect:—

Egg.—I expect the egg of the insect is deposited within the flower or very young fruit. The mango tree blossoms at the close of the cold season. Unless therefore there are two broods of the *curculios*, which is not likely to be the case, the pest must live through the drenching rains of the rainy season, and the low temperature prevailing in the cold months; and, whether it attacks the flower or young fruit, it must be in a fit condition, when the mango trees blossom or their young fruits form, to deposit its ova. . . I doubt very much if the eggs of the mango *curculio* are laid in the season previous to their being hatched. . . .

Larva.—The larvæ answer the general description of larvæ in the weevil family; they are white, fleshy, thick, footless grubs, with fleshy tubercles instead of legs,² and while there were three or four of them in one mango I have not found more than one pupa, or one perfect insect in any single fruit. The larval stage is passed in the fruit and the larvæ were obtained from a ripe mango.

Pupa.—The pupal stage is passed in the fruit and only one pupa is found in a single fruit. The pupal stage would seem to be short, seeing that the larvæ were obtained from a ripe mango.

Imago.—The specimen of the imago examined was a little over one quarter of an inch in length, and about one-eighth of an inch in breadth; and to ensure identity was taken fresh from the heart of the fruit. Almost black when first removed from the mango, on being dried it assumed a lighter, rusty-brown hue. The head of the weevil is produced into a rostrum, with ten-jointed antennæ on its sides which are elbowed beyond the long scape and terminate in a knob. The elytra are very convex and extremely hard; and together with the rostrum and feet, are covered with scales of a light-yellowish colour; these scales are not brilliant. The imago form is attained in the fruit itself. . . . Plate III (i), shows the larva, pupa, and imago, dorsal and ventral views of *C. mangifera* all enlarged. "In almost every case examined the weevil was about one-third off the further end of the drupe, while there were no indications of its having worked its way from the surface, or the stem through the pulp to the cell . . . The insect is found in the adult phase of its existence in the months of May, June and July . . . I think it probable that the imago lives over from one season to the next, and that in the interval it hides away in crevices under the bark or in rubbish, etc. In this connection it is perhaps of some importance to note that if it hibernates in the localities suggested then its dingy colour is distinctly protective."

The following shows diagrammatically the probable life history of this insect and the time taken to complete one cycle. The

¹ Printed in the Journal of the Agricultural and Horticultural Society of India, Volume VIII, Part II, new series.

² Packard, page 448.

periods would vary slightly according to the time of flowering of the mango :—

YEAR.	January.	February.	March.	April.	May.	June.	July.	September.	October.	November.	December.
1896	†† —	— — ●†	†††	†††	†††	†††	†††	†††	†††
1897 . .	†††	†††	††								

Explanation—

† = Imago and egg stage.

† = Imago.

— = Larval stage.

● = Pupal stage.

— = Period during which most damage is done to the tree and during which the imago lays its eggs and is therefore most dangerous.

Locality from where reported.—The geographical range of this pest is extensive. It does not yet affect all the mango-producing districts of India, but its march is progressive. The insect is a good example of the enormous damage weevils, in their attacks, can effect.

The species was originally described from Mauritius; it also occurs in Madagascar.

4. *Astycus lateralis*, Fabr.—

Fabr. Ent. Syst. I. 2, p. 454. Boh. in Schönh. Gen. Curc. VI. 1, p. 249.

Tree attacked.—Chir (*Pinus longifolia*, Roxb.).

This is thought to be the insect reported by Thompson as tunnelling into Chir wood in the North-Western Provinces, often rendering it unfit for use. This tunnelling would be done by the larvæ of the beetle.

The imago is a small greenish beetle which has been reported



FIG. 36.—*Astycus lateralis*.

as defoliating mulberry bushes in Rangoon, and also as destructive to garden plants in Darbhanga. This defoliation would be the work of the imago.

Figure 36 represents the imago enlarged with much magnified figure of the antennæ. Natural size of insect is indicated by hair lines.

5. *Sipalus granulatus*, Fabr.

Fabr. Syst. El. II, p. 432.

Boh. in Schönh. Gen. Curc. IV, p. 803.

But in Zemming and Von Harold's catalogue, S. granulatus is given as a synonym of S. gigas. Fabr. Syst. Ent., p. 127.

Tree attacked.—Dhak (*Butea frondosa*, Roxb.).

This insect is thought to be the species reported by Mr. Thompson as tunnelling into the dhak tree.

Egg.—This is probably laid in the bark of the tree.

Larva.—Mr. Thompson states that he obtained larvæ from the interior of the tree.

Pupa.—Pupæ were obtained from tunnels in the wood, but Mr. Thompson makes no mention of the method of pupation or of the position of the larvæ in the tree when pupating.

Imago.—The imagoes are about one inch in length. They are said to be found in borings, congregated in colonies together. The circular holes are as much as an inch in diameter and seven to eight inches in depth.

Locality from where reported.—*S. granulatus* is thought to be the insect reported by Mr. Thompson as tunnelling into the dhak

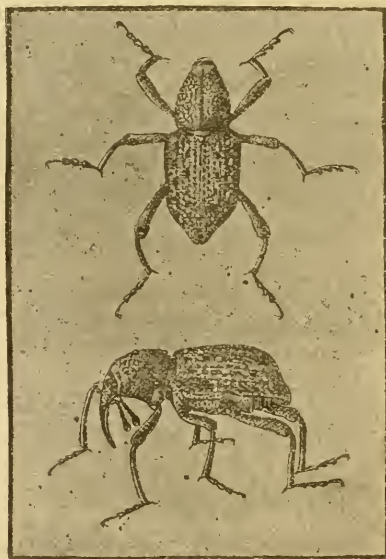


FIG. 37.—*Sipalus granulatus*.

tree in the forests of the North-West Himalayas. Figure 37 shows the dorsal and side view of this insect, both natural size.

6. *Sphenophorus planipennis*, Gyll.

Gyll. in *Schönh. Gen. Curc. IV*, p. 911.

Tree attacked.—Cocoanut (*Cocos nucifera*, Linn.).

This beetle has been reported to injure the cocoanut tree in Ceylon (Nietner).

7. *Odoiporus* sp.

Tree attacked.—Preng bamboo (*Arundinaria aristata*, Gamble).

This beetle was found by the writer on the Preng bamboo in the Sikkim forests at an elevation of 5,500 feet. It is a pretty beetle, rosy in colour, and is found on the wing from the middle of April to near the end of May. It is said by the natives to injure both the shoots and stems of the bamboo.

This insect was sent to the Indian Museum, Calcutta, by the writer in July 1896, and was placed in the genus *Odoiporus*, the species being unknown.

8. *Apion strobilanthi*, Desbroch.

Desbr. in litt.

Tree attacked.—Kibu (*Strobilanthus pectinatus*, T. And.) fodder plant.

This insect was reported by Mr. G. Rogers as attacking the fodder plant called Kibu, which grows at an elevation of about 6,000 feet in Sikkim. In the rains of 1889 the only plant observed to flower by Mr. Rogers had the whole of its seed destroyed by this insect.

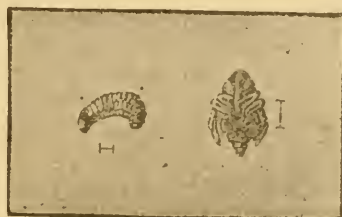


FIG. 38.—Larva and Pupa of *Apion strobilanthi*.



FIG. 39.—Imago of *A. strobilanthes* and Kibu pod attacked by it.

Specimens were sent to Monsieur Desbrochers de Loges, who determined the insect as a new species of *Apion*, which he named *Apion strobilanthes*.

The Kibu plant is an herbaceous weed and is largely used for fodder. Figure 38 represents the larva and pupa of this insect both enlarged. Natural size is shown by hair lines. Figure 39 shows the insect with its antenna (much enlarged); also a kibu pod attacked by it.

9. *Genus ? species ?*—

Tree attacked.—Mahogany (*Swietenia Mahogani*, Linn.).

Some undetermined *Curculionid* larvæ were sent to the Indian Museum, Calcutta, as very destructive to young mahogany trees in the Western Duars. The larvæ were found tunnelling underneath the bark. Nothing further seems to have been reported concerning this forest pest.

10. *Genus ? species ?*

Tree attacked.—Sal (*Shorea robusta*, Gærtn.).

A minute undetermined weevil was said by Mr. Thompson to have been very destructive to sal seed in the North-West Provinces in the year 1863. Entire seed crops are said to have been destroyed in that year, and partial destruction of them has been observed since. Mr. Thompson writes as follows:—

“During May and June of this year (1867?) I was enabled to devote some considerable time in observing the ravages committed by these insects. Their mode of attack is that common to the whole family, *viz.*, the insertion of the eggs in the stigma of the flower which, when developed, has introduced the young larvæ, which are hatched meanwhile, into the recently formed fruit.

In this the larvæ live till nearly mature when, by their encroachments towards the peduncle or stalk they cause the fruit or seed to fall and thus serve a purpose they have in view of making their escape into the earth to undergo the transformation into the pupa state. Before the seeds can have been perfectly ripe they are thus caused to fall to destruction."

It should not prove a difficult task to discover and get classified this insect, concerning whose life history so much has been observed by Mr. Thompson.

11. *Genus ? species ?—*

Tree attacked.—Oaks (*Quercus pachyphylla*, Kurz, and *Quercus lamellosa*, Sm.).

Another small undetermined weevil has been reported as destroying 90 per cent. of the seed of the valuable oak (*Q. pachyphylla*) in the Darjiling forests. The only specimens obtained were sent with the above information to the Indian Museum, Calcutta, by Mr. C. G. Rogers of the Forest Service from Darjiling. The specimens were small grubs about a quarter of an inch in length and of the characteristic *curculionid* shape. These were, however, insufficient for identification.

In January 1896 the writer noticed that about eighty-five per cent. of the seed of the oak (*Quercus lamellosa*) trees in the British Sikkim forests was useless. The seed was found to be attacked by *curculionid* larvæ, but the attempt to obtain specimens of the imago was a failure.

12. *Genus ? species ?—*

Tree attacked.—Kadam (*Anthocephalus cadamba*, Miq.).

Specimens of a *curculionid* pupa were found in the pupa cases shown in Plate IX*b*. by the writer in the Tista Valley, Eastern Himalayas, in April 1896. The pupal cases were situated between the bark and wood of a Kadam tree and were numerous.

The pupæ had the ordinary *curculionid* appearance, and were lying in a loose semi-elliptical cocoon made of chips of wood and bark.

Specimens of the cocoon and pupa were sent to the Indian Museum, Calcutta, but they proved insufficient for identification.

Plate IX*b*. shows the cocoon *in situ* on the tree, the bark having been removed. Also the pupa lying in the cocoon and the pupa alone, ventral surface, all natural size.

13. *Genus ? species ?*

Tree attacked.—White Siris (*Albizia procera*, Bth.).

Specimens of *Curculionid* beetle were found by the writer in April 1896 in a white siris tree in the Tista Valley, Eastern Himalayas. The tree had been blown down during the previous rains. The beetles, which were mostly only about three parts mature, were extremely numerous, the wood being absolutely riddled with tunnels.

Specimens of these beetles were forwarded to the Indian Museum, but owing to their not being fully developed they could not be identified.

I have since made some over to Mr. W. F. Blandford, who has kindly volunteered to name them for me. He states that the insect is a Cryptorrhynchid weevil, but has not as yet determined its name.

Family XI.—*Scolytidæ*.

This family of beetles, known as 'bark borers,' comprises numerous species which are destructive to forest trees in India. Conifers in particular are especially liable to attack. The damage is chiefly caused by the larvæ, which bore up and down between the bark and the wood of the tree, leaving behind them patterns on the wood of a very definite character in most cases, although recent research tends to show that this does not apply to wood-boring "ambrosia" feeders. Like other wood-boring insects the beetles prefer diseased or dying trees for their attacks. Thus forest fires and bad attacks of leaf-feeding caterpillars are almost sure to be followed by an increase of *Scolytidæ* in the forests. When very numerous these beetles will attack healthy trees, should no sickly or dead ones be present. The attacked tree answers to the attacks by a flow of sap which drowns the bark-borers in their burrows, but by degrees the tree loses vitality and the beetles win.

1. *Diapus impressus*, Janson—

Jan. Ind. Mus. Notes, Vol. III, No. 1, pp. 74-75.

Tree attacked.—Oak (*Quercus* sp.)

This beetle is red-brown in colour and shining, with pale-yellow legs and antennæ and an oblong thorax. Its length is three and-a-half to four millimetres. Figure 40 shows a dorsal and side view of the imago with some enlarged diagrams of legs; natural size is shown by hair lines.

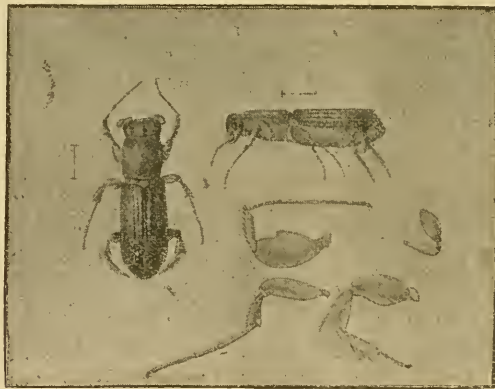


FIG. 40.—*Diapus impressus*.

Locality from where reported.—*D. impressus* has been reported as attacking oak stumps in Deoband, North-Western Provinces. The specimens were found in December 1881 and sent to the Indian Museum for identification.

NOTE.—*Scolytidæ* are divided into two sub-families, *Platypini* and *Scolytini*. *D. impressus* is the only species of the *Platypini* that will be mentioned in this pamphlet. The imagoes of the *Platypini* differ in appearance from the ordinary 'bark-borers' or *Scolytini*. Very little is known about the sub-family.

2. *Polygraphus* sp.¹—

Tree attacked—Kail (*Pinus excelsa*, Wall.).—

This is a minute beetle, brown in colour, and has been reported as tunnelling into the bark of *Pinus excelsa* trees.

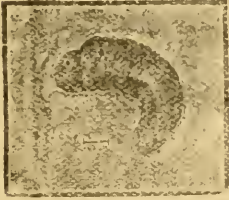


FIG. 41.—Larva of *Polygraphus* sp.



FIG. 42.—Imago of *Polygraphus* sp.



FIG. 43.—Antennæ and legs of *Polygraphus* sp.

¹ This beetle is allied to *Polygraphus pubescens* of Europe. For an account of *P. pubescens*, vide Eichhoff, Eur. Borkenkäfer, page 122 (1881).

The figures, Figs. 41 and 42, show the larva and imago enlarged. Figure 43 shows much magnified diagrams of the antennæ and legs of the beetle. The topmost leg is the front one; also a side view of the imago.

Locality from where reported.—In May 1891 the Conservator of Forests, School Circle, forwarded from his camp near Chakrata in the North-West Himalayas a log of *Pinus excelsa* attacked by the above *Scolytid*. The insect was said to have attacked some trees that had been girdled and were dying. The specimens were submitted to Mr. W. H. Blandford, Lecturer on Entomology at the Royal Indian Engineering College, Cooper's Hill. Mr. Blandford determined them as belonging to a species of *Polygraphus* near to the European form *Polygraphus pubescens*, Linn.

3. *Pityogenes scitus*, Blandf.—

Blandf. Ind. Mus. Notes, Vol. III, No. 1, pp. 63-64.

Tree attacked.—? Dingsa (*Pynus kasya*, Royle).

This species is very closely allied to the European *Pityogenes chalcographus*, from which it has been separated by Mr. W. H. Blandford only after very careful comparison.

Egg.—As the imagoes sent to the Indian Museum, Calcutta, were forwarded on the 4th April, it may be concluded that eggs are laid during the first two to three weeks of this month in the bark of the tree attacked, but there are probably two to three broods per annum.

Larva.—No notes on the appearance of the larva have apparently been as yet made, but on emergence from the egg they probably at once commence to bore their way through the bark till they reach the wood and then tunnel in this.

Pupa.—Probably only a short time is spent in this stage.

Imago.—The beetle is black in colour and 17 to 2 mm. in length. Figure 44 shows the imago, dorsal view; also much enlarged diagrams of the legs and antennæ. The actual size of the insect is shown by the hair line.



FIG. 44.—*Pityogenes scitus*.

The beetle emerges about the beginning of April, and after copulation begins to lay its eggs, probably in the bark of a conifer. The female probably bores a burrow in the bark, laying its eggs in small cavities on either side of the main tunnel. An important point to establish is the length of time that the generation from these eggs takes to mature. It is not improbable that *P. scitus* has several generations in the year, and from a Forester's point of view the determination of their number is of the first importance. It would be useless attempting preventive measures in nurseries and elsewhere unless the more or less exact number of times during the year that flights of beetles might be expected were known.

Locality from where reported.—Specimens of this *Scolytid*, reported by the Officiating Deputy Conservator of Forests, Sib-sagar, Assam, to be injurious to the Makai tree (*Shorea assamica*), were sent to the Indian Museum, Calcutta, through the Director of the Forest School, Dehra Dun. The insects were forwarded from Assam on April 4th. As above mentioned, they were reported as attacking the *Shorea assamica*. Specimens were sent to Mr. W. H. Blandford of the Royal Indian Engineering College, Cooper's Hill, for identification. In determining them Mr. Blandford noticed that other species of *Tomicus* and *Pityogenes*, in the modern limits of these genera, are only found in conifers. Some small pieces of stick, that were originally forwarded with the insects, were therefore sent to the Royal Botanical Gardens, Sibpore, for further examination. Here they were examined by Dr. G. King, who found that they were not *S. assamica* twigs but possibly *Pinus Kasya*; the sticks were not, however, sufficient for precise identification. Therefore the tree that is attacked by *P. scitus* is a conifer. To settle the point definitely any *Scolytids* attacking *P. Kasya* should be forwarded for identification.

4. Genus? species?—

Trees attacked.—Oak (*Quercus incana*, Roxb.) ; Sâl (*Shorea robusta*, Gærtn.) ; Chir (*Pinus longifolia*, Roxb.) ; and Galgoja (*Pinus Gerardiana*, Wall.).

Undetermined species of *Scolytidæ*, perhaps identical with some of the above, have been noticed as very destructive in India to the oak (*Quercus incana*) ; also to immature sâl, chir, and *Pinus Gerardiana*. Like the bamboo borer (which belongs, it may be noted, to the *Bostrychidæ*) these insects are known in the North-Western Provinces as Ghoon (Thompson).

NOTE.—*Xyleborus perforans*, Wollaston.—It may be mentioned here that a *Scolytid* named *Xyleborus perforans* bores into beer casks in India, causing thereby a loss of the liquid, which spouts out of the holes made by the insect when it leaves the wood. The beetle is known to Commissariat Sergeants by the not inappropriate name of "Tippling Tommy". This beetle was deter-

mined by Mr. Blandford, who has written a pamphlet on its life history. Owing to its wood-eating proclivities it may be found to attack our coniferous trees.

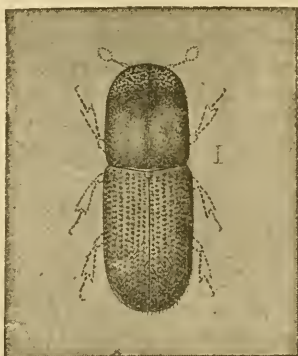


FIG. 45.—*Xyleborus perforans*.

Figure 45 is a magnified drawing of a specimen of *Xyleborus perforans* from the West Indies presented to the Indian Museum by Mr. W. F. H. Blandford.

Family XII.—*Cerambycidae*.

This large family of beetles contains a number of insects which are extremely destructive in Indian forests. The damage is chiefly done by the larvæ, which bore right into the heart of the tree and, when very numerous, render the wood useless for any purpose save firewood. The fact that our best timber trees, such as teak, sâl, khair, saj, etc., suffer badly from these pests shows that the family is a dangerous one to forest trees. The larvæ, in many cases, pass several years within the tree before the pupal stage is reached, and during this period are burrowing up and down the tree and eating voraciously. Further damage is also often done by this family in the imago state, the beetle girdling the twigs of trees. The portion above the girdle dies and the female, who has laid her eggs in this, thus secures for her offspring a supply of young and soft dead wood to commence life on.

1. *Celosternia scabrata*, Fabr. The Sâl Girdler.

Fabr. *Spec. Ins.* I, p. 224.

Tree attacked.—Sâl (*Shorea robusta*, Gärtn.).

The habits of this insect are probably very similar to those of the American Hickory Twig Girdler (*Oncideres cingulatus*, Say.)¹.

Egg.—The eggs are probably laid by the female in notches in the bark of the sapling near the top of the shoot during the latter part of the rains.

¹ This insect is described by Packard in Bull. No. 7 of the United States Entomological Commission, p. 71 (1881).

Larva.—The larvæ, on emerging from the eggs, feed upon the dead wood of the shoot, the upper portion having been girdled by the beetle, at a point below where she laid her eggs, in order to kill it.

Pupa.—The larva probably changes to the pupal state within the dead wood of the girdled stem. In the case of the American species it has been found that the groove generally weakens the branch to such an extent as to cause it to break off and fall to the ground with the first wind. Therefore it is probable that the dead portion of the stem may have fallen to the ground by the time the larva changes to the pupal stage.

Imago.—The imagoes are found on the wing during the rains and it is during the latter end of this season that the damage is done to the plants. This damage is wholly due to the girdling of the shoots by the imago, the larva merely feeding on the dead wood provided for them by the beetle. Plate III (2) shows an imago of *C. scabrata*, natural size.

Locality from where reported.—In a paper published in the *Indian Forester*² Captain E. Wood, Conservator of Forests, Oudh, wrote that during the rains coppice sâl saplings suffered from an insect which ringed the bark generally within a foot or two of the top of the shoot, the part above consequently dying and the coppice shoot becoming crooked or bifurcated.

Specimens of the insect were forwarded through the Director of the Forest School, Dehra Dun, and proved to be *C. scabrata*.

From the above description of the method of attack of this beetle, the remedy in plantations is obvious. The dead tops from all stems and all dead twigs on the ground should be collected and burnt. It is possible that they all contain eggs or larvæ, and the destruction of these will go a long way towards exterminating the pest. This procedure, however, is only applicable to small areas.

2. *Cælosterna spinator*, Fabr.

Fabr. Ent. Syst. Suppl., p. 145.

Tree attacked.—Babul (*Acacia arabica*, Willd.).

Egg.—The egg is probably laid in the bark of the tree.

Larva.—The larva is said to enter the stem some three or four inches above the ground and to tunnel through the root to such an extent as to eventually cause death.

Pupa.—Not described.

Imago.—This greatly resembles *C. scabrata*, of which it is only a variety. *C. scabrata* has the pubescence of the elytra more tawny or brownish in colour.

² *Indian Forester*, November 1888, p. 503.

Locality from where reported.—A single specimen of this beetle was forwarded by the Conservator of Forests, Berar, through the Director of the Imperial Forest School, Dehra Dun, to the Indian Museum, Calcutta, with the information that it does considerable damage to babul (*Acacia arabica*) plants. The species proved to be new to the Museum collection of *Cerambycidae* and was therefore sent home to the British Museum, when it was examined by Mr. Gahan. He identified it as a rather small specimen of the male *C. spinator*, but at the same time remarked that the species should be placed as a variety of *C. scabrata*. If its habits prove to be the same as those of *C. scabrata* it will not in future be described under a separate name.

3. *Plocoderus obesus*, Daporet = (*P. pedestris*, Cotes).

Daporet, Dej. Cat. 3 ed., p. 347.

Trees attacked.—Sâl (*Shorea robusta*, Gærtn.); Jinghan (*Odina woderi*, Roxb.); Dhak (*Butea frondosa*, Roxb.); Semul (*Bombax malabaricum*, D.C.); Amara (*Spondias mangifera*, Willd.).

This is no doubt the insect referred to by Mr. Thompson in his report as attacking sal, jinghan, etc.

Egg.—Mr. Thompson states that he has found beetles on the wing as early as March, and also in November, so the eggs would probably be laid some time during the rainy months in Northern India.

As the insect appears to enjoy a very wide distribution all over India, the egg-laying period doubtless varies with the elevation and latitude. The eggs are probably laid in the bark.

Larva.—On emergence the larvæ bore through the bark and sapwood, and, as they get older, burrow right into the heart of the tree. The length of time spent in the larval stage not improbably exceeds a year, but definite observation is required to determine this point.

Pupa.—The larva when pupating forms a peculiar solid calcareous egg-shaped cocoon, and in this changes into the pupal stage. The following is an extract from Mr. Thompson's report on this stage:—

"The pupæ were discovered in solid cocoons made of a substance resembling lime. The shell was fully the sixteenth of an inch in thickness, quite hard and firm, offering in fact more resistance to the pressure of the fingers than would a pigeon's egg. They were discerned underneath the bark imbedded between it and the wood in a felled dhak tree."

In a foot-note Mr. Thompson adds (and the writer can corroborate from personal observation the statement about the depth):—

"I have since obtained numerous specimens of these beetles and their cocoons imbedded to the depth of eight inches in logs of *Odina wodier* and *Bombax heptaphyllum*" (probably *B. malabaricum*).

Imago.—According to Mr. Thompson the beetles are found on the wing as early as March and are also to be seen in November. The beetle varies from one to two inches in size, the antennæ being longer in the male than in the female, as shown in Plate III (3). The figures show the calcareous cocoon, the female beetle, and the head of the male insect, all natural size.

Locality from where reported.—This is the insect reported by Mr. Thompson as attacking the sâl in the forests of the North-Western Provinces.

Specimens of the beetle were forwarded to the Indian Museum by the Director of the Forest School, Dehra Dun. It was said to attack sâl and jinghan.

P. obesus appears to have a fairly wide range in India. The Museum contains specimens from Calcutta, Maldah, Jalpaiguri, Sikkim, Sibsagar, Naga Hills, Dehra Dun, Ceylon, and the Andaman Islands.

The writer obtained some cocoons from an amara tree (*Spondias mangifera*) on April 14th, 1896 in the Tista Valley, Eastern Himalayas, at about 900 feet elevation. The cocoons were taken up to Kalimpong (elevation 4,000 feet) and an attempt made to breed out some imagoes, but without success. A cocoon sent to the Indian Museum, Calcutta, in July 1896 was identified as *P. obesus*.

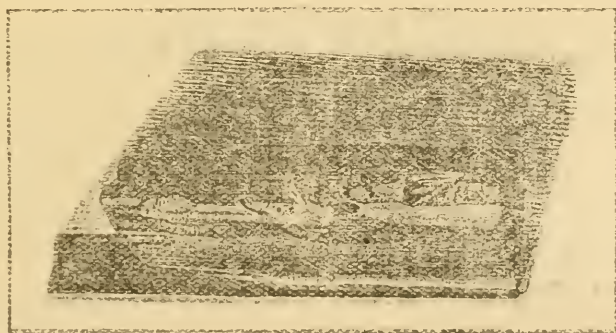


FIG. 46.—A piece of sâl timber attacked by larvæ of *P. obesus*.

Figure 46 represents a block of sâl timber, one-seventh natural size, which has been tunneled by the larvæ of *P. obesus*.

4. *Pachydissus holosericeus*, Fabr.—(*Cerambyx vatica* of Thompson and *Neocerambyx holosericeus* of Indian Museum Notes).

Trees attacked.—Sâl (*Shorea robusta*, Gærtn.); Saj (*Terminalia tomentosa*, W. and A.); Teak (*Tectona grandis* Linn.); Farash (*Tamarix articulata*, Vahl.); Babul (*Acacia arabica*, Willd.); and Makai (*Shorea assamica*, Dyer).

Egg.—The egg is probably laid in the bark of the tree attacked. Mr. Thompson in his report states, as an observed fact, that barked trees are never attacked, in other words the insects require the softer bark to lay their eggs in, the young larvæ with their, as yet, weak mandibles being unable to feed on the harder heart-wood.

Larva.—The larvæ appear to live at first in the sap-wood and then as they get older they tunnel right into the heart of the tree.

Pupa.—As yet unnoticed.

Imago.—This insect whilst resembling *P. obesus* as regard build and size, differs from it and is remarkable for the golden brown pubescence with which its whole body is covered, this giving it a golden sheen first in one part of its body and then in another as it is turned round in a strong light. The sexes may be distinguished by the possession of longer antennæ in the male. The beetle varies in size, specimens in the Indian Museum, Calcutta, varying from seven-eighths of an inch to one and a half inches. Plate III (4) shows the female insect and a head of a male beetle, both natural size.

The following is an extract from Mr. Thompson's Report. He alludes to the insect under the name of *Cerambyx vatica*:—

"The sâl is attacked by beetles, *Cerambyx vatica* In its healthy and vigorous state the stem of the sâl is apparently never attacked by any description of insect, but no sooner has the flow of healthy sap ceased than a host of young larvæ are hatched This *Cerambyx* never attacks the timber when the bark has been removed, and it is only after the tree has been killed and the bark allowed to remain, that it is resorted to by the beetles for the purpose of breeding. The experiences and observations of seven years I can offer as satisfactory evidence of the truth of these assertions.

"One is sometimes, however, struck on seeing an apparently healthy tree bearing the appearance of harbouring these insects from the excremented powdery sawdust-looking particles, which is the sure indication of their presence within the timber. On closer examination it will be observed that the abode of the larvæ is confined to a certain space on or around the trunk, and further investigation will invariably prove that portion to be either diseased or injured in some way or other; so that a division of the sap had occurred, partial decay had set in, and thus prepared the apparently healthy trunk for the reception of the insects.

"During the whole of my experiences, extending as they do to all the forests of Kumaon and Garhwal, from the Sarda to the Ganges, I have never during the whole course found any other description of beetle except the little *Buprestid* previously reported (*Chrysobothris scznolata*), attacking sâl wood."

This last statement of Mr. Thompson's is curious, as the writer has found in the Singhbhum forests, Chota Nagpur, a species of *Hoplocerambyx* (described below), a species of *Acanthophorus* (a *Prionid*), and two *Bostrychid* beetles, *Bostrychus jesuita* and *Sinoxylon anale*, all attacking sâl wood and often very seriously affecting its utility.

Locality from where reported.—Specimens of *Pachydissus holosericeus* were forwarded to the Indian Museum, Calcutta, by the Director of the Forest School, Dehra Dun, with the report that they had been found attacking sâl in Oudh, and saj in Dehra Dun.

This beetle has also been reported as attacking the teak tree in Kulsî, Assam; also as attacking *Tamarix articulata* and *Acacia arabica* in Dehra Ismail Khan.

In August 1891, a block of makai wood (*Shorea assamica*) was received in the Museum, Calcutta, from the Deputy Conservator of Forests, Lakhimpur Division, Assam. It was found to be tunnelled in all directions by *Cerambycid* larvæ. A beetle that emerged was found to be closely allied to *P. holosericeus*, only differing in possessing a row of spines on the antennæ.

5. *Hoplocerambyx spinicornis*.—Newn. Singhbhum Sâl Borer.

Newn. *Entomol. I*, p. 245.

Tree attacked.—Sâl (*Shorea robusta*, Gærtn.).

The following are some rough notes on the life history of this insect made from personal observations by the writer in the Singhbhum sâl forests in Chota Nagpur. They are believed to be the first that have appeared on the habits of this pest, which I call the Singhbhum Sâl Borer.

Egg.—This stage has not been noticed up to date (1897).

The beetles are found on the wing in the latter part of May, all June and into July. It is probable that the eggs are laid in the bark of the tree in June and July.

Larva.—The exact date of emergence from the egg of the larva has not been definitely ascertained, but the writer is inclined to think that August is the month during which the larvæ chiefly hatch out. They then bore into the sap wood, and as they increase in size and their stout mandibles become larger and stronger, they bore their way into the heart of the tree. The writer has seen numerous instances of broad gauge sleepers, cut from sâl trees of

nine-foot girth and over, the wood of which has been riddled by these larvæ. This of course greatly impairs the longevity of the life of the sleeper and may lead to its rejection as useless for railway purposes. The time passed in the larval stage is probably more than one year, but the period has not been as yet properly observed. When extended the full grown larva is from two-and-a-half to three inches in length and possesses the broad head and powerful mandibles of a *Cerambyx* larva. Plate IXc shows a drawing of a full-grown larva obtained from a sâl sleeper by the writer on February 1st, 1897.

Pupa.—The pupation of this beetle is somewhat curious. Before changing to this stage the larva closes the outer opening of the tunnel with a peculiar calcareous formation resembling in consistency the coating of the cocoon of *Plocoderus obesus*. The tunnel is lined for an inch or more with this substance, then the outer end is closed up. When *in situ* this partial cocoon from the outside resembles a Brazil nut in shape, it being flattened out at the end into a kind of beak-shaped edge. The covering is white in colour and rather fragile. The writer has found the larvæ and these semi-cocoons at all depths in the tunnels within the tree, and it appears to be immaterial at what depth the former changes its state.

The pupating season would seem to be about the middle of February, and in the middle of March an inspection of some cocoons disclosed the pupa about half mature, the antennæ, legs, and head of the beetle being nearly complete, though still white and pulpy in consistency.

Imago.—The beetles are found on the wing from the latter part of May, through June and into July. They are brown in colour, about $1\frac{1}{2}$ inches in length, with long antennæ, longer in the male than in the female. They couple during June and July, and it is probable that the female then sets about finding a suitable tree to lay her eggs in. It is probable that the life of the imago is from two to three months.

These beetles are very pugnacious when disturbed. One caught hold of the writer's finger and made his mandibles meet in it; force had to be employed to make the insect loose its hold. The beetle had just issued from a sleeper.

The insects make a loud stridulating noise, produced by rubbing over one another the dorsal plates of the prothorax and mesothorax. This cricket-like "chirping" was particularly noticeable in the sleeper depôts in Singbbum in the evenings during June, 1897, when numbers of these insects were issuing from the timber.

Plate IVa shows the imago, ♀, of this *Cerambyx*; b represents the, ♂, showing the long antennæ.

The above life history may be shown diagrammatically as follows. The cycle is not complete, as it is not yet known how long the insect spends in the larval stage.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1897					† † †	† † † †	— — —	— — —	— — —	— — —	— — —
18.....	Number of years	larva continues	feeding	is unknown							
18	— — — —	● ● ● ●	● ● ● ●	● ● † †	† † † †						

Locality from where reported.—Numerous specimens of this insect were obtained from sâl trees in the Singhbhum Forest Division, Chota Nagpur. Some of these insects were sent to the Indian Museum, Calcutta, in June 1897. The beetle was placed by the Museum authorities in the genus *Neocerambyx*, but the species was new to the Museum. Mr. W. Blandford, however, named it from the British Museum as *Hoplocerambyx spinicornis*.

With an insect of this kind in the forest it will be understood that felling or ringing trees a year or two in advance, to allow of the wood seasoning somewhat before being cut up, is an absolute impossibility. Not only would a large amount of timber be lost owing to the attacks of insects of this class, but the presence of the dying and dead wood in the forest wood lead to an enormous increase of the pests themselves, the conditions being so entirely in their favour.

6. *Stromatium barbatum*, Fabr.—“Kulsi Teak Borer.”

Fabr. Syst. Ent., p. 189.

Trees attacked.—Teak (*Tectona grandis*, Linn.) and Khair (*Acacia catechu*, Willd.).

Some confusion appears to have arisen between this insect and its ally *Stromatium asperulum*. As the latter is a Malay insect, and only one Indian specimen of it exists in the Museum, it is probable that *S. barbatum* is the real “Kulsi borer” in Assam.

Egg.—The egg is laid in the bark of young trees from one to six years of age (one to two years old appear to be preferred) near the surface of the ground.

Larva.—The young larvæ on hatching bore into the young stem of the plant. Their presence can usually be marked by a swelling in the stem near the ground, and below this swelling can often be seen a small puncture from which excrement of the grub

protrades. Figure 47 shows a piece of stem of a young teak tree



FIG. 47.— Piece of young teak stem attacked by larvæ of *S. barbatum*.

from the Kulsi plantation, Assam, with the swelling caused by the attack of this larva. The figure is copied from a photograph and is one-eighth natural size. The puncture below the swelling represents no doubt the tunnel formed by the young larva in boring its way into the stem from the spot where the egg was previously laid by the mother beetle in the bark. After a hot day the affected trees tend to have a faded appearance, but this symptom is not always present, and some trees remain apparently healthy until the larva has tunnelled so far into them that they snap off with the wind. The swelling which appears where the borer is at work is thought to be due to the efforts made by the tree to repair the damage and to strengthen the stem where it is being weakened. These efforts appear in many instances to be successful, for the trees often recover. Larvæ are to be found in young teak stems all the year round, so that the insect takes probably at least two



FIG. 48.—Larvæ of *Stromatium barbatum*.

years to pass through its various stages. Figure 48 represents the larva of this insect.

Pupa.—No mention has been made of this stage. It is probably short, as larvæ taken at the end of March produced perfect insects on the 21st June of the same year.

Imago.—In Gauhati some beetles were reared from some teak stems by the Forest Officer. The imagoes issued from the stems



FIG. 49.—Imago of *Stromatium barbatum*

in the end of June. These stems in March had only contained larvæ. Figure 49 shows a dorsal and side view of the imago. The insects were reared from khair wood.

Locality from where reported.—In February 1890 specimens of this insect were sent to the Indian Museum, Calcutta, by the Deputy Conservator of Forests, Kamrup, Assam. The insects were reported to have proved destructive to young teak trees in the Kulsi plantation, the pest having appeared simultaneous with the formation of the plantation.

On a reference being made to the Museum collection a specimen of *S. asperulum* was found marked "Kulsi teak borer," and this is probably the insect described by Mr. A. G. Mein in a note in the *Indian Forester*.¹ With the exception of this solitary specimen reported from India, *S. asperulum* has been obtained from the Malay Peninsula only. An application was therefore made to the Forest Officer at Kulsi for further specimens. These were received and proved to be of three distinct species of *Cerambycidae*—*Stromatium barbatum*, *Pachidissus holosericeus* and *Ægosoma lacertosum*, the species *S. asperulum* being unrepresented. The probabilities are that it will be found that *S. barbatum* is chiefly responsible for the damage done. It would, however, be satisfactory if the Deputy Conservator at Kamrup could settle the matter by rearing some beetles from some carefully selected young stems known to contain larvæ. These beetles could then be identified.

The insect has also been noticed as attacking dry khair wood in the Dehra Dun museum.

The preventive measure adopted in the Kulsi plantation in 1879 was to coppice all young trees that were badly attacked and to encourage the growth of the strongest shoot from the stool to form a new tree by removing all other shoots as fast as they appeared. It was found best to leave older and more vigorous trees alone, provided they showed no signs of fading, as in many cases they recovered.

7. *Stromatium asperulum*.—White.

White. *Longic.* VIII, 2, 1855, p. 300; *Pascoe Trans. Ent. Soc. Lond.* Ser. 3, III, 1869, p. 532.

Tree attacked.—Teak (*Tectona grandis*, Linn.).

As mentioned above, only a single specimen of this insect exists in the Indian Museum, Calcutta, reported from India. Its habitat is apparently the Malay Peninsula. The specimen in the Museum was probably sent by Mr. A. G. Mein, as it is tabulated "Kulsi Teak borer."

At present it is needless to do more than mention this insect here, as it does not appear to be a true Indian species.

¹ *Indian Forester*, Vol. IV, pp. 347 to 349.

It will be interesting, however, to have the question as to which is the true "Kulsi Teak borer" cleared up.



FIG. 50.—*Stromatium asperulum*.

Figure 50 shows the imago of *S. asperulum*.

The insect was originally described from Hong-Kong.

8. *Batocera rubus*.—Linn.

Linn. Syst. nat., ed. X, p. 390. *Larva. Blandi. Hist. Nat. Ins.*, 1845, t. 11.

Tree attacked.—Cocoanut (*Cocos nucifera*, Linn.).

This is a large beetle said to tunnel into cocoanut trees (Short). This insect is the "curuminga" of the Cingalese, but not much else seems to be known about its life history, although it has been often described and figured.

9. *Batocera*, *sp.*

Tree attacked.—Wild Willow (*Salix tetrasperma*, Roxb.).

A species of *Batocera* was reported by Thompson as boring into the Wild Willow tree. He writes as follows:—

"The Wild Willow (*Salix tetrasperma*) is also attacked in a living state by another "Monochamus" beetle, which enters the trunk and bores through it in all directions, ejecting the triturated particles through holes made for the purpose."

Nothing further seems to have been reported as to the life history of this insect, and its species is undetermined.

10. *Batocera*, *sp.*

(*Monochamus soongna*, Thompson.)

Tree attacked.—Semul (*Bombax heptaphyllum* [malabari-

cum, DC.]), Sanjna (*Moringa pterygosperma*, Gœrth.) and the Roongra (*Erythrina suberosa*, R.).

Yet another unnamed species of *Balocera* has been reported on by Thompson as follows :—

“*Bombax heptaphyllum*, Sanjna, and Roongra, are attacked by a magnificent beetle, the *Monochammus soongna*, one of the *Cerambycidae*. The larvæ of this insect, which are extremely large and armed with powerful mandibles, are very destructive to the woods I have described Out of a log of sanjna I have collected forty-three perfect insects, about a dozen larvæ and five to six pupæ ; the log was not above six feet in length and about thirty inches in girth.”

No further information has appeared on this insect.

11. *Ægosoma lacertosum*, Pascoe.

Ann. Nat. Hist. (3) XIX, p. 413.

Tree attacked.—Teak (*Tectona grandis*, Linn.).

On the request of the Indian Museum authorities, Calcutta, for further specimens of the Kulsi teak plantation borer, Assam, this insect was sent in company with *Stromatium barbatum* and *Pachydissus holosericeus*.

Nothing further seems to be known of its life history.

12. *Sthenias grisator*, Fabr.

Mant. I, p. 136.

Tree attacked.—*Tabernacmontana* sp.

Egg.—This is laid in the bark of a branch of the tree near its summit, the branch being girdled below where the eggs have been laid.

Larva.—The larva on its emergence from the egg at once bores its way into the dead wood of the girdled twig or branch and feeds on the dead wood. This branch may, and probably often does, get knocked off or blown off by the wind and falls to the ground. As the larva is by this time safe inside the twig this does not affect him.

Pupa.—The larva changes to the pupal state inside the dead twig.

Imago.—The beetle is about three quarters of an inch in length. It does damage by girdling twigs and branches, its object being to provide a supply of dead wood in which to lay its eggs. By girdling a branch the upper part above the girdle dies, and it is in the bark of this that the beetle has already laid her eggs. The male insect may be distinguished from the female by a small process projecting upwards from the base of each of the mandibles



FIG. 51.—*Sthenias grisator*.

in front of the clypeus. Figure 51 shows a dorsal and side view of the mature beetle.

Locality from where reported.—This Longicorn was forwarded to the Indian Museum, Calcutta, through the Madras Museum in November 1892 by the Collector of Kurnool. He reported that it had been noticed cutting rings of considerable depth and about an inch in diameter completely around the branches of a *Tabernaemontana* *sp.* tree. The insect was identified by Mr. Gahan of the British Museum. Mr. Gahan mentioned that the British Museum contained a specimen taken more than 30 years ago near Coimbatore which bears a ticket with the following note:—"Gnaws the bark of shrubs and is very destructive".

The same species was subsequently forwarded to the Indian Museum in January 1893 through the Director of the Imperial Forest School. In this case it was obtained by the Deputy Conservator of Forests, Coorg, who wrote:—

"These beetles cut off the stems clean in one night. . . . Large rose trees are thus cut down and destroyed. It is incredible that a small insect like the one I send can do such damage, and I would not have believed it had I not seen the ravages myself. . . . They attack the main stem and despise the smaller branches. The rose stems were from half an inch to three-quarters of an inch in diameter, and were cut completely off with remarkable neatness."

This girdling is probably done by the beetle, it having laid its eggs in the stem and twigs above.

13. *Xylorrhiza adusta*, Wiedem.

Wiedem, Zool. Mag., 13, 1819, p. 182.

Tree attacked.—Dudhi (*Wrightia tinctoria*, R. Br.).

This Longicorn was forwarded through the Director of the Forest

School at Dehra Dun in September 1893, from the Conservator of Forests, Southern Circle, Madras. It was reported as "ringing" the branches of *Wrightia tinctoria*, a habit which does not appear to have been previously noticed in connection with this species.

14. *Acanthophorus serraticornis*, Ol.—

Ol. Ent., IV, 66, p. 14, t. 9, f. 33. Larva; Lucas. Ann. Soc. Ent. Fr., 1854. Bull. p. 47.

Tree attacked.—Sâl (*Shorea robusta*, Gærtn.).

Specimens of this beetle were obtained in the Singhbhum sâl forests, Chota Nagpur. It was found on the wing by the writer in August 1896 and again in June 1897. Beyond the fact that it attacks decaying sâl wood the writer has been unable to make any observations on its habits and life history. The beetle was determined in the Indian Museum as belonging to the genus *Acanthophorus*, but the species was unknown.

The insect was named for me by Mr. W. F. Blandford, who tells me there is only this one well known species described.

15. *Genus? species?*

Tree attacked.—Sauer (*Betula cylindrostachys*, Wall.).

A single specimen of a *Cerambycid* beetle was found in a Sauer tree in the Sikkim forests, Eastern Himalayas, at an elevation of 5,500 feet. The beetle was obtained by the writer on April 28th, 1896, and sent to the Museum for identification in July 1896. It proved to be new to the Museum and unrepresented in the collection.

16. *Genus? species?*

Trees attacked.—*Robinia*, sp. and *Albizzia*, sp.

In June 1894 specimens of a larva found destructive to young seedlings of *Robinia* and *Albizzia* were forwarded by the Director of the Imperial Forest School, Dehra Dun, from the Forest Officer, Chenab, with the information that the larva is said to live about nine inches below the ground, and, cutting through the tap root of both species, feeds upon the pulpy portion of it.

The specimens proved to be the larva of a *Cerambycid* beetle, but the material sent to the Museum was insufficient for precise identification.

NOTE.—(1) *Xylotrechus quadripes*, Chevr.—Coffee-borer.

Chevr. Mon., 1863, p. 293; Dunning Trans. Ent. Soc. Lond., 1868, pp. 126 and 105 (larva).

This insect is the well-known coffee-borer of Southern India. It has not as yet been reported as attacking forest trees, but it is mentioned here owing to the fact that it has proved such a terrible pest to coffee bushes. The damage is effected by the larva—a

white, fleshy, legless grub, which bores into the wood of the stem of the coffee bush and kills the plant. The beetle is about three-quarters of an inch long.

In 1867 it proved exceedingly destructive in Southern India to coffee bushes. Figure 52 represents the imago, both natural size and enlarged.



FIG. 52.—*Xylotrechus quadripes*.

(2) During the recent (1896-97) departmental operations undertaken in the Singhbhum Forest Division, Bengal (one of the homes of the sâl tree) under which the Division undertook to supply two lakhs of broad gauge sâl sleepers to the Rae-Bareilly-Benares Railway, it was most noticeable that the large amount of dead and dying wood of necessity lying about, consequent on the opening out the forests, resulted in an enormous increase in the numbers of of *Cerambycid*, *Bostrychid*, and to a lesser extent, *Scolytid* beetles. The writer noted in 1897 that sickly trees and trees that had been blown down during the monsoon of 1896 were riddled by *Cerambycid* beetles of which *Hoplocerambyx spinicornis* (whose life history has been described already) was one of the chief offenders. At a rough estimate the writer considered that somewhere about 0.5 per cent. of the sleepers cut were more or less damaged by the borings of these beetles. This percentage rapidly increased if the sleepers were left lying in the forest for any length of time. During June 1897 *H. spinicornis* and *Sinoxylon anale* swarmed in the sleeper depôts, and the former could be seen issuing from the sleepers in all directions, a proceeding which at times caused the rejection of the sleeper by the railway passing Engineer.

TRIMERA.

No forest trees are badly attacked by this group of beetles, although slight defoliation may take place.

Family XIII.—*Coccinellidæ*—Ladybird beetles.

This family of beetles is unimportant in forestry. The beetles are usually carnivorous, but one genus and its allies form an exception to this rule, being leaf-eaters.

1. *Epilachna viginti-octo-punctata*, Fabr.

Fabr. En. Soc. V. I., p. 282, 1792.

This beetle is mentioned here as it belongs to a leaf-eating genus. It has been reported as defoliating *Cucurbitaceæ* in Dehra Dun. It has also been reported as destroying whole fields of brinjal (*Solanum melongena*) plants in Bardwan and Balasore.

As above mentioned, *Coccinellidæ* are mostly carnivorous. This genus and its allies, which form Lacordarie's tribe *Coccinillidæ phytophages*, are an exception to the general rule.

Figure 53 shows the imago of this insect.

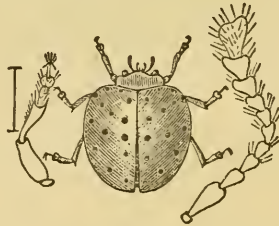


FIG. 53.—*Epilachna viginti-octo-punctata*

CHAPTER IV.

HYMENOPTERA.

TEREBRANTIA.

The following tree has been reported as attacked by a species of this group :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
CYNIPIDÆ {	1. Teak, (<i>Tectona grandis</i> Linn.).	Galls produced on shoots and branches.

Family I.—*Uroceridæ*.

This family of the *Terebrantia* group of the *Hymenoptera* includes the wood wasps. These insects are in Europe very like wood-boring beetles in character. They feed in standing sickly coniferous trees, and inhabit cut timber of buildings. The damage that is done affects the commercial value of the wood after it has been felled.

None of the *Uroceridæ* have as yet been reported to damage wood in Indian coniferous forests.

Family II.—*Tenthredinidæ* ("Saw Flies").

The larvæ of these insects are very like caterpillars (*Lepidoptera*) and are called "saw flies." They feed on the leaves of plants, and in Europe, of trees (*e.g.*, *Lophyrus pini* or the Scotch Pine). *Tenthredinidæ* have been reported as attacking rose bushes in the Dehra Dun Forest School compound, but do not seem as yet to have been reported from the forest.

Family III.—*Cynipidæ*.

1. *Genus ? species ?*

Tree attacked.—Teak (*Tectona grandis*, Linn.).

A species of *Cynipid* has been reported from the Ellichpur Division as producing galls on the teak tree.

The following note was furnished by the Forest Ranger :—

"Some teak trees were observed to present a knotty appearance just below the node of the leading shoots and branches in compartment No. 3 of the Chourakund Circle. To this attention was drawn by the Conservator of Forests, Hyderabad Assigned Districts, and observations were ordered to be made. These knotty portions when cut transversely showed that in the middle small eggs were laid for the future insect. These eggs have been found

to be laid in four along the four-sided stem of the teak, and each group to contain from twelve to twenty-four eggs.

"These eggs were hatched during the beginning of July, and the insect in its larva stage bored its way out. Some of the borings possess the coat cast out by the insect while undergoing the metamorphosis."

Locality from where reported.—The Director, Imperial Forest School, Dehra Dun, forwarded to the Indian Museum, Calcutta, in July 1895 specimens of an insect said to attack teak trees in the Malghat forest of the Ellichpur Division.

The specimens consisted of dead chrysalids of a minute *Hymenopterus* insect belonging to the family *Cynipidæ*, the material being insufficient for identification.

ACULEATA.

The wood of the following trees is attacked by species of this group :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
APIDÆ	{ 1. Kathgular (<i>Ficus glomerata</i> , Roxb.)	Wood tunnelled into.
VESPIDÆ	{ 1. Musre katus (<i>Castanopsis</i> <i>tribuloides</i> , A.DC.)	Do. do.

Family IV.—*Apidæ*.

1. *Xylocopa* sp.

Tree attacked—*Ficus glomerata*, Roxb., and the woods of other trees.

Species of *Xylocopa* have been reported as tunnelling into most kinds of wood. The insects are called "carpenter bees."

Mr. Thompson writes thus concerning this insect :—

"These bore tunnels into timber where they collect honey and the farina of flowers, leaving a lump of this compound in a divided cell for the nourishment of the young larva when it is hatched. Each cell has with the egg a separate supply of this food. The larvæ are hatched sub-cylindrical, whitish worms . . . They change into the pupal state within their respective cells and come out the perfect bee after a brief period."

Mr. Thompson further remarks that in the North-West Provinces there are three species; a large one very destructive to wood work of buildings, also to the dead wood of forest trees; a second which was procured from a *Ficus glomerata* tree, and a third and smaller species which lives in colonies and burrows with great energy. This one, as it lives in gangs, is more destructive, and bored into thick trunks of Huldoo (name?) to such an extent as to render them useless for any other purpose save firewood.

Xylocopa are said to be very destructive to the timbers of buildings regularly inhabited in the Kanara district, the tunnels being sometimes as much as three-quarters of an inch in diameter.

The writer has observed *Xylocopa* boring into the beams of tea factories in the Duars, thus weakening their supporting power and in cases endangering the stability of the roof. A species of this Duars *Xylocopa* was procured at the beginning of March 1895, when several specimens were noticed on the wing. The specimen obtained has not yet been identified.

Mr. B. H. Baden-Powell mentions in the *Indian Forester*¹ that a species of *Xylocopa* attacks dead but not living sâl in the Dehra Dun Forests (Siwaliks).

Family V.—*Vespidæ*.

1. *Vespa* sp.

Tree attacked.—Musre katus (*Castanopsis tribuloides*, A. DC.). A species of *Vespa* was procured by the writer from the decaying stumps of a Musre katus tree. The insect was just mature when cut out of its cell, and very beautiful in colour when first exposed to the light.

Locality from where obtained.—The specimen was obtained on April 28th, 1896, in the Loolagaon Forest of the Tista Division, Eastern Himalayas, at an elevation of 5,500 feet, by the writer.

It was forwarded to the Indian Museum, Calcutta, in July 1896 for identification. The insect was stated to belong to the genus *Vespa*, but the species was new to the Museum.

¹ Note on the Dehra Dun in the *Indian Forester*, Vol. I, p. 21, by Mr. B. H. Baden-Powell.

CHAPTER V.

DIPTERA.

BRACHYCERA.

This group has not as yet been reported as doing much damage in Indian forests. The following tree is attacked :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
MUSCIDE	1. Mango (<i>Mangifera indica</i> , Linn.).	Fruit tunnelled into.

Family I.—*Muscidæ*.1. *Dacus ferrugineus*, Fabr.

Fabr. Ent. Syst, IV; *Wiedm Ausser. Europ. Zweiflug. Ins.*, 2nd pt., Hamm., 1830, p. 515.

Tree attacked.—Mango (*Mangifera indica*, Linn.).

Larva.—The larvæ of this fly have been reported as doing considerable damage to mangoes. When full grown they are about the size of grains of boiled rice, and are to be found in the pulp of the fruit attacked by them.

Locality from where reported.—The pest was reported as doing considerable damage in Mozufferpore and afterwards from Berhampore. Regarding its presence in the latter place, Babu N. G. Mukerji writes :—

“ They annually visit one of the famous orchards of this district, the Katgola garden, and spoil almost every fruit of the Maldah varieties, which ripen later than those of the country varieties.” This observation is interesting, as some doubt was expressed as to whether really sound fruit is attacked by this insect.

2. *Rivellia persicæ*, Bigot.

I M. Notes, Vol., I, p. 192; *Cat. Dipt. Orient. Reg.*, III, 1892, p. 221.

Tree attacked.—Mango (*Mangifera indica*, Linn.); Peach (*Prunus persicæ*).

Egg.—The skin of the sound fruit is perforated by the imago and the eggs deposited in it, unless there is a wound on the fruit, when the eggs will be deposited in it.

Larva.—The larva feeds on the fruit. When full-grown, the fruit having meantime fallen to the ground, it burrows its way into the earth and changes there to the pupal state.

Imago —The imago issues on the eleventh day after pupation.



FIG. 54. —*Rivellia persica*.

Figure 54 shows the imago of *Rivellia persica*.

Locality from where reported.—This pest has been reported as attacking the fruit of the mango and peach, destroying in the latter case one-half to two-thirds of the crop, according as to whether the rains were early or late.

When this family is better known it may be found that both the seed and leaves of our forest trees suffer to a certain extent from their attacks.

NEMOCERA.

Family II.—*Cecidomyiæ*.

This family comprises a large number of slender bodied flies which lay their eggs in the tissues of plants and often produce galls as in the case of the *Hymenopterus* family, *Cynipidæ*.

None of the family seem to have, as yet, been recorded as destructive in Indian forests.

CHAPTER VI. LEPIDOPTERA.

RHOPALOCERA (*Butterflies*).

Rhopalocera are not important in Forestry. They damage trees to a small extent, especially fruit trees, in the larval state. The following trees have been reported as defoliated :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
PAPILIONIDÆ .	{ Bael (<i>Ægle Marmalos</i> , Correa.).	Leaves eaten.
	{ Ber (<i>Zizyphus Jujuba</i> , Lam.).	Do.
HESPERIDÆ .	{ Cocoanut (<i>Cocos nucifera</i> , Linn.).	Do.

Family I.—*Papilionidæ*.

The damage is done by the larvæ, who defoliate the trees attacked.

1. *Papilio erithonius*, Cramer.

Tree attacked.—Bael (*Ægle Marmalos*, Correa.), Ber (*Zizyphus Jujuba*, Lam.) and other fruit trees.

Egg.—The eggs are smooth, spherical and pale yellow in colour, and are always laid on the very young shoots of the tree.

Larva.—When hatched out the larva begins to feed on the young leaves and shoots. When young the larvæ resemble bird droppings and rest on the exposed side of the leaf. When full-grown they are bright green in colour and rest on the stems of the leaves, where they are hidden.

Pupa.—The pupa is angular in shape and is suspended from the food plant by a silken cord.

Imago.—The imago is very particular in ovipositing, and never lays more than three eggs on one plant. Plate V shows the imago, pupa, ventral and side view, and larva of this insect.

Locality from where reported.—Specimens were sent to the Indian Museum, Calcutta, from Bangalore with the information that the insect attacked lemon trees.

In 1889 specimens were sent from the Saharanpore Botanical Garden, where the insect was reported as doing much damage to young budding orange trees.

De Niceville in the *Asian*¹ wrote that he found the larvæ most frequently on the Bael tree, but that in Calcutta it also feeds on the orange, pomelo and ber trees.

¹*Asian* of 7th February 1888.

Family II.—*Hesperiidae*.

As in the previous family, the damage in this one is done by defoliating larvæ.

1. *Gangara thyrsis*, Fabr.

Tree attacked.—Cocoanut (*Cocos nucifera*, Linn.).

Egg.—The egg, which is spherical in shape, is laid on the upper surface of the cocoanut frond.

Larva.—The larvæ appear in from eight to ten days after the egg is deposited, and immediately draw a section of the leaf together, first cutting it laterally to enable it to be drawn into a cylinder by means of a fine silken thread. In this cylinder the larvæ live, travelling out at night to feed. In appearance the larvæ somewhat resembles that of *Attacus atlas*, but they are of course very much smaller. They are covered with white filaments, which appear as if powdered with flour. There are two patches of scarlet on the segments near the head, placed laterally.

Pupa.—The larva changes into the pupal state within the rolled up part of the leaf.

Imago.—The imago, which is shown in Figure 55, is a medium-sized stout butterfly.

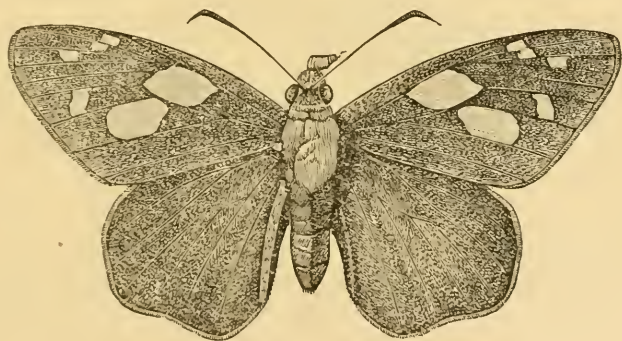


FIG. 55.—*Gangara thyrsis*.

Locality from where reported.—Specimens of this *Hesperid* butterfly were received through the Director of the Forest School, Dehra Dun, from the District Forest Officer, North Malabar, who reported that this caterpillar was very destructive to young cocoanut palms in his district.

HETEROCERA (*Moths*).

NOTE.—The classification in Hampson's *Moths of India* has been followed to the end of Geometrinæ. The volume containing the remaining families has not yet been published.

Next perhaps to the great order *Coleoptera* the *Heterocera* contains the most dangerous pests that a forester has to deal with. Both as defoliators and wood-borers are these pests to be found in our Indian forests, and the destruction accomplished by them is sometimes on an enormous scale.

Families.—*Saturniidae* and *Bombycidae*.

These are two of the great silk-yielding families of the *Heterocera*, and many of them have a commercial value. The larvæ are defoliators, but have not been as yet reported as doing much damage in Indian forests. Only these two families will be noticed here. In Europe defoliating larvæ of these families do a serious amount of damage to conifers.

The following are a few trees defoliated by these insects :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
SATURNIIDÆ	1. Sâl (<i>Shorea robusta</i> , Gærtn.).	Defoliation.
	2. Saj (<i>Terminalia tomentosa</i> , W. and A.).	Do.
	3. Ber (<i>Zizyphus Jujuba</i> , Lam.).	Do.
	4. (<i>Michelia</i> , sp.) . . .	Do.
BOMBYCIDÆ	1. Peepul (<i>Ficus religiosa</i> , Linn.).	Do.

NOTE.—Numerous other trees might be mentioned, but as up to date the insects have proved to be important more from their commercial value than as pests, it is considered unnecessary to do more than allude to the group.

Family III.—*Saturniidae*.

1. *Antheraea paphia*, Linn.—The Tusser Silk-Worm.

Linn. *Syst. Nat.* I, p. 809 = *Antheraea mylitta*, Drury *Exot. Ins.* II, pl. 5, fig. 1.

Trees attacked.—Sâl (*Shorea robusta*) ; Saj (*Terminalia tomentosa*) ; Ber (*Zizyphus Jujuba*).

Larva.—The larva is a brilliant green in colour adorned with numerous tubercles.

Pupa.—The pupa is enclosed in a cocoon of fine structure which is attached to the food plant by a strong stalk.

Imago.—The moth is a large, buff-coloured insect with curious transparent ocelli-like small windows in its wings. The insect goes through two generations in the year.

Locality from where reported.—The insect is found in a wild state all over India, and feeds on a variety of trees, while it is regn-

larly cultivated in Chota Nagpur, Central India and Southern India, giving a large outturn of silk yearly.

The figure, Plate VI, shows the male and female moths; also the cocoon and caterpillar.

2. *Antheraea assama*, Westw.—Muga Silk-Worm.

Westw. *Cub. Or. Ent.*, p. 41, pl. 20, fig. 2; *C. and S.* No. 1559.

Tree attacked.—*Michelia*, sp.

Resembles the Tusser insect, but differs therefrom both in the nature of the cocoon, which has no stalk, and in the shape and markings of the moth and larva. The insect goes through about five generations in the year, and is reared in Assam in much the same way as the tusser is reared in Chota Nagpur. The larva feeds on *Michelia* sp., etc.

Plate VII shows larva, pupa, and imago of *A. assama*.

3. *Antheraea frithii*, Moore.

Moore, *P. Z. S.*, 1859, p. 256, pl. 65, fig. 1; *C. and S.* No. 1561.

Tree attacked.—Sâl (*Shorea robusta*, Linn.).

This insect is common at low elevations in Sikkim. The larva feeds on the sâl and the insect hybernates as a pupa. It is bivoltine, the moths appearing in March and again in August.

Family IV.—*Bombycidae*.

1. *Gunda sikkima*, Moore.

Moore *P. Z. S.*, 1879, p. 406, pl. 33, fig. 3; *C. and S.* No. 1112, *Aristhala sikkima*, Moore.

Tree attacked.—*Ficus religiosa*, Linn. and others.

A small moth reported from the Sikkim forests.

It spins its cocoon on the underside of a leaf. The cocoon is glistening white in colour and contains a good deal of fine silk. The caterpillar does some damage as a defoliator.



FIG. 56.—*Gunda sikkima* ♂.

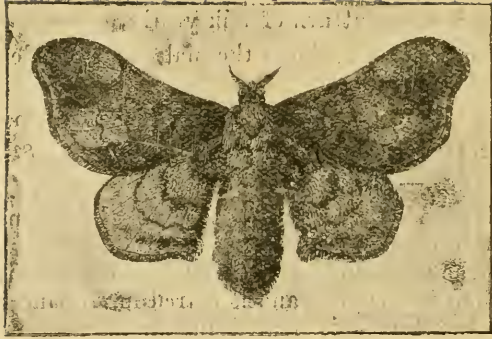


FIG. 57.—*Gunda sikkima*. ♀

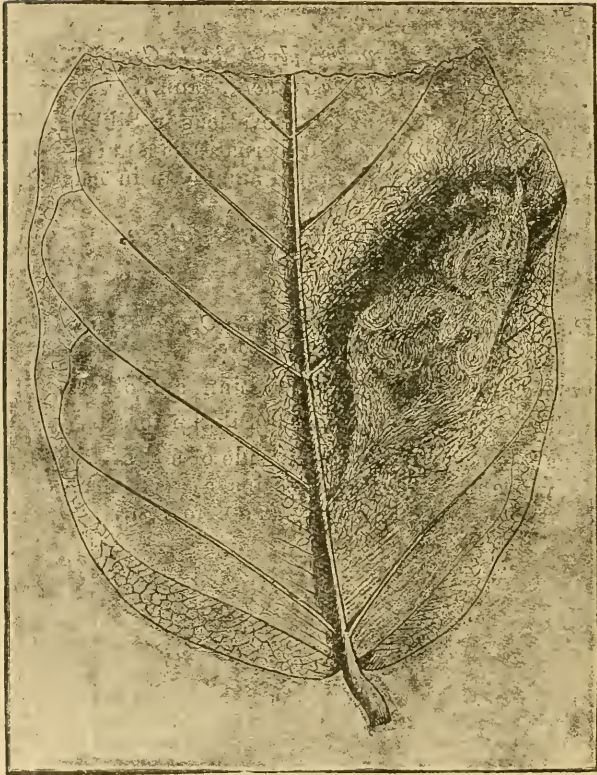


FIG. 58.—*Cocoon of Gunda sikkima*.

Figures 56 and 57 represent the male and female moths. Figure 58 shows part of a leaf with a pierced cocoon attached to it.

Family V.—*Eupterotidae*.

Species of this family have been reported as swarming over the country and devastating growth of all kinds, the damage being done by the larvæ.

1. *Eupterote minor*, Moore.

Moore, *Indian Mus. Notes*, Vol. III, No. 2, p. 89, genus *Spalyria*, Moore.

Tree attacked.—Herbaceous plants and shrubs.

Some hairy larvæ of this moth were sent to the Indian Museum, Calcutta, in November 1891 through Mr. De Nicéville from Rangoon, with the information that the insect had been very destructive.

In a report received from the Northern Division, Shwabo, Burma, it was stated that a plague of hairy caterpillars had appeared which literally covered the country, destroying the herbage and swarming on the roads to such an extent that thousands of them must be trodden under foot by passing wayfarers. Contact with the hairs produces irritation and even sores. The larva is said to turn into a species of yellow moth about August.



FIG. 59.—Larva of *Eupterote minor*.

The Burmese name for the insect is "Pagunde" or "Rugaungde." Figure 59 shows a dorsal and side view of the caterpillar (natural size).

Locality from where reported.—This pest was sent to the Calcutta Museum from Burma, and the authorities forwarded it to Mr. Moore for identification. By the latter it was determined as *E. minor*.

It is curious that in the above account no mention is made of trees having been attacked by the insect. In a swarm of this magnitude it is extremely probable that trees suffered to some extent, and yet there does not seem to have been any report to this effect. In the event of a fresh swarm it would be interesting to know something more about the habits of the pest in this respect.



FIG. 60.—*Eupterote minor*, ♂.



FIG. 61.—*Eupterote minor*, ♀.

Figure 60 shows the male and Figure 61 the female of *E. minor*.

2. *Genus? species?*

Tree attacked.—Búk (*Quercus lamellosa*, Sm.).

The following note was sent to the Indian Museum, Calcutta, by Mr. C. G. Rogers of the Forest Service, from Darjiling:—

“In April 1890 a blackish, hair-covered, processional caterpillar, about two inches in length, defoliated the Búk (*Quercus lamellosa*) trees over an area of about twelve miles long by eight miles broad, near Darjiling; the trees, which were in some cases as much as seventy feet in height, being often completely denuded of their leaves. Much injury was not done, however, as at the time that the caterpillar appeared the trees had only their last year's leaves upon them, while they put forth their young leaves again in the following June.”

Beyond the information contained in the above note nothing further seems to have been reported on this insect.

Family VI.—*Sesiidæ*.

The wood-boring families of the *Heterocera* contain some of the most destructive of forest insect pests. In the larval state they are wood-borers, and in the amount of damage they are capable of doing to wood they, although their numbers are perhaps less numerous, rival the *Coleopterous* families *Bostrychidæ*, *Scolytidæ* and *Cerambycidæ*. The larva can always be distinguished from *Coleopterous* ones by the possession of the characteristic fleshy abdominal prolegs of *Lepidoptera*.

A species of this family has been reported to tunnel into the wood of a poplar tree, completely riddling it.

1. *Trochilium omniatæforme*, Moore. Baluchistan Poplar Borer.

Moore, M. S.=genus *Sphecia*, Hubn. Verz., p. 127 (1818).

Tree attacked.—Poplar (*Populus euphratica*, Olivier).

The following is the probable life history of this pest :—

Egg.—The eggs are probably laid in the bark of the tree attacked in the early part of the cold weather, say during the last week in October and first part of November. A part of the cold weather is probably passed in this stage.

Larva.—The larvæ probably emerge about the beginning of January. They at once commence boring through the bark, and in April, when they are about half-grown, they may be found between the bark and the wood. From this time they commence boring straight into the heart-wood, getting well into it before the sap commences to rise in the spring. They remain tunnelling through the wood till about September.

Pupa.—In September the larvæ commence to change into pupæ. These are to be found in cocoons made of chips and situated near the entrances of the burrows, as shown in Figure 62.

Imago.—The imagoes appear in October. Specimens were reared in the Indian Museum, Calcutta, from stumps of poplar received from Baluchistan. The moth is a small clear-winged *Sesiid*, and so closely resembles the wasp *Vespa cincta* in appearance as to be easily mistaken for it when looked at superficially; and this resemblance, as in the case of other mimicking insects, no doubt affords the moth protection from the attacks of birds, the latter being careful not to meddle with *V. cincta* and its powerful sting. It may be mentioned here that the characteristic of the *Sesiid* family is that the imagoes resemble small hawk moths (*Sphingidæ*) with the scales gone from the wings (therefore called "clear wings"). Some species, as in this

case, often have a striking resemblance to wasps. Figure 62 shows a section of a tunnel containing the cocoon of chips in which the

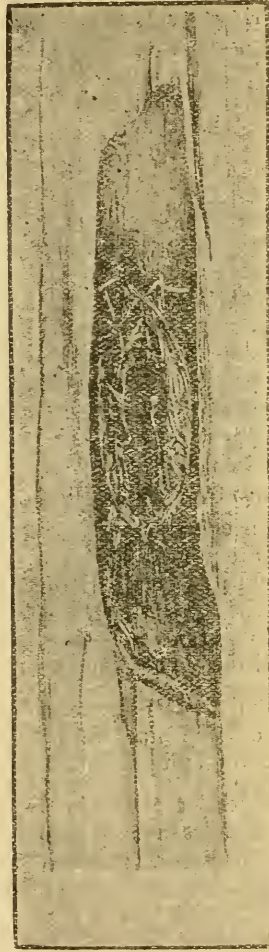


FIG. 62.—Cocoon of *Trochilium omniatiforme*.

pupa is formed. Figure 63 shows the larva, pupal case and imago



FIG. 63.—Larva, pupal case and imago of *Trochilium omnatiiforme*.

of the insect, whilst Figure 64 shows a section of the trunk of a young poplar tree from Baluchistan, one-tenth natural size, showing the tunnels made by the larvæ of this moth.

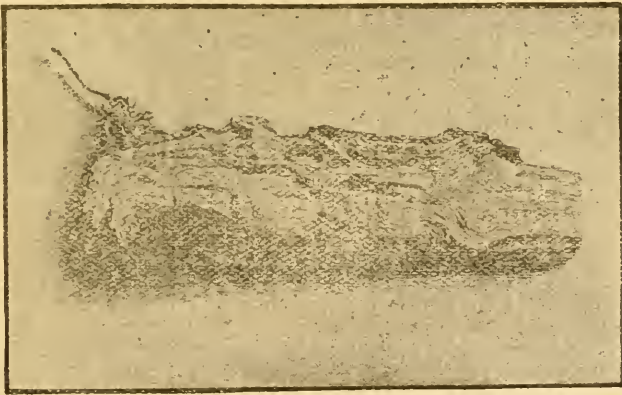


FIG. 64.—Section of Poplar, one-tenth natural size, showing attacks of *T. omnatiiforme*.

The following shows diagrammatically the above life history, etc., the life cycle being taken as one year only:—

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1897										†	†††††	†††††
1898	—	—	—	—	—	—	—	—	●●●●●	●††††	†	

Locality from where reported.—According to Mr. Cleghorn the Poplar tree (? *Populus euphratica*), which constitutes the most generally useful wood of the country (Baluchistan), suffers severely from the attack of a boring insect. This insect proves to be the larva of the *Sesiid* moth *Trochilium omnatiaforme*. The poplar trees are grown from cuttings, and when about two years old are almost invariably attacked by the caterpillar, which bores through the trunk and riddles it in all directions close to the ground, generally killing off the stem before it reaches the age of five years but leaving the roots intact, so that fresh shoots, *i.e.*, coppice shoots, come up from the ground. These shoots, having well established roots to support them, generally manage to survive the attack of the insect and to repair the damage by throwing fresh wood around the injured portion. The loss therefore that is occasioned by the insect chiefly consists in the throwing back of the growth of the young trees by two or three years. Now as the tree is a fast-growing one, this loss is very considerable, two-year old trees being often as much as fourteen feet in height with stems of two and-a-half inches in diameter when they are killed down by the pest. Out of thirty-five trees planted out five years previously, Mr. Cleghorn found remaining eight of the original trees which had survived the attack of the insect, fifteen trees, each apparently from three to four years old, and twelve trees, each one to two years in age, all coppice shoots from the original roots, the first shoots having been destroyed by the insect. The percentage of trees attacked was found to be very much smaller in 1891 than in 1890, a result which Mr. Cleghorn attributes to the hardness of the winter of 1890-91.

The above serves as a good illustration of the enormous amount of damage an insect can do in a plantation, if it once gets firmly established in it.

Family VII.—*Psychidæ*. (Bag Worms.)

The larvæ of this family defoliate many plants in India, and do some damage in our forests. The family may be recognised by the fact that the larva always lives inside a bag or bundle of sticks (resembling a bundle of faggots *en miniature*) or rolled up leaf, which it carries about on its back after the manner of a snail and its shell.

The following are the trees reported as damaged by the group :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
PSYCHIDÆ	1. Sal	(<i>Shorea robusta</i> , Gærtn.) Defoliation.
	2 Gall nut tree	(<i>Terminalia Chebula</i> , Retz.) do.
	3.	(<i>Lagerströmia</i> , sp.) do.

1. *Clania variegata*, Snell.

Snell. Tijd. Ent., xxii, 1879, p. 114. — *Eumeta sikkima*, Moore, *Ind. Mus. Notes* ii, No. 1, p. 67 (1891).

Tree attacked.—Sâl (*Shorea robusta*, Gærtn.).

Egg.—The female lays her eggs about the beginning of March in the pupal shell, within the case, among the remaining loose scales which have not been emitted and which serve as a protection for the eggs. After laying nearly all her eggs her abdomen so decreases in size that she falls out of her case and dies. The eggs are yellow, smooth ovals, slightly squared at the ends and unmarked. The outer covering is not hard and shell-like, but simply a skin, and the slightest touch will put the egg out of shape and render it useless.

Larva.—The larvæ emerge about the 1st of April from the eggs laid in March. This is the first brood of the year, but the others do not follow in any regularity, and their number during the year has not been ascertained. Both larvæ and pupæ are found in all stages during the rains. The larvæ when they first emerge are about one-sixteenth of an inch in length; colour, reddish brown; head, large, with strong mandibles. Only after about the third or fourth day do they begin to form cases from bits of moss and bark of sâl trees, on the young leaves of which they feed. The larva never leaves its case once it has begun to enlarge it. The mouth of the case is made flexible so that it can be drawn in with the head. Later on in life the larva seems to prefer the old sâl leaves as food. When about to change to the pupal stage the case is fastened to a twig or on to the bark of the tree, and the mouth of the case is drawn out in the shape of a neck, which is then closed. The larva then proceeds to cover the inside of the case with a very fine loose silk, and then turns round inside so as to hang head downwards.

Pupa.—In the male the pupa is shiny, dark mahogany coloured and cylindrical. In the female it is much thicker than in the male and of a lighter reddish brown, and when the pupa changes into the imago state only the top head and thoracic segments of the shell are thrown off, and the insect cuts its way out of the lower end of its cocoon by means of its sharp-edged beak.

Imago.—As is usual in this family, the male moth is alone perfectly developed. The female never leaves her case and is a mere bag of eggs (after coupling) without, it is said, any wings, limbs, eyes, or antennæ.

The male has highly pectinnated antennæ, and is about two and-a-half inches across the wings.

The female has some means of attracting the male to her, and copulation takes place by the male settling on the head

of the female and forcing his abdomen in between the pupal shell and the body of the female. Figure 65 shows (1) the ♂ moth ;

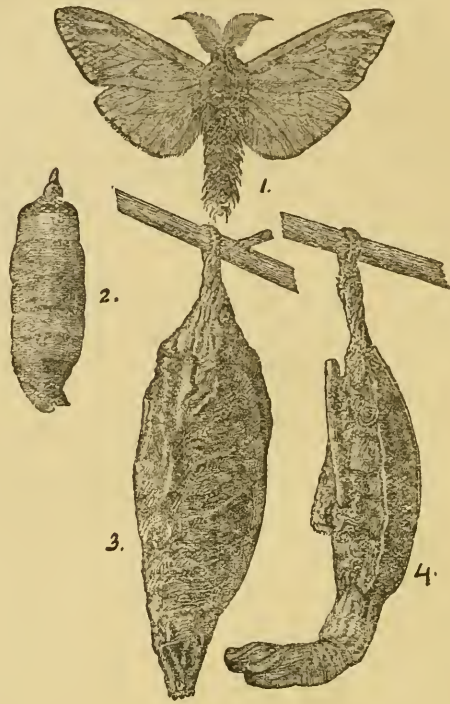


FIG. 65.—*Clania variegata*.

(2) the degraded wingless female as she appears when taken out of the case ; (3) the larval case in which the female passes her existence ; (4) the larval case of the male with pupal skin protruding from which the male moth has emerged. The figures are all natural size.

Locality from where reported.—This insect was reported by Mr. Dudgeon as attacking the sâl tree and tea bushes in the Darjiling District. Mr. Dudgeon wrote: "The larva of this moth is found everywhere in the Darjiling District where sâl trees grow, and would be perhaps the most to be feared as a pest should it increase greatly, which it has apparently little to prevent it doing. It appears, however, to be little known, probably on account of its ability of hiding itself within its case made of moss, bark, and dried leaves, and in this way becomes indistinguishable from the bark or twigs near which it may be suspended whilst feeding."

Since Mr. Dudgeon described *C. variegata* the writer has also noticed it to be common in the sâl forests of the Darjiling District.

2. *Acanthopsyche* (*Metisa*) *moorei*, Heyl.

Heyl. Bull. Soc. Ent. Belg., 1890, p. 2. = *Babula grotei*, Moore, J. A. S. B. lix, pt. 2, p. 262.

Trees attacked.—Gall nut tree (*Terminalia Chebula*, Retz.) and *Lagerströmia* sp.

Egg.—The eggs are probably laid by the female moth inside her case, which she never quits.

Larva.—The young larvæ first thatch themselves with little rough bits of leaf, gradually adding to the case thus constructed and making it bigger and neater as they grow older. When full grown they spin themselves up into their cases, which they suspend from some convenient branch by silken threads. They then turn themselves round inside the case so that the head rests in the position previously occupied by the anal extremity.

Pupa.—In the above-mentioned position the larva shuffles off its larval skin and becomes a pupa.

Imago.—The male imago emerges from what was formerly the anal end of the larva's case, and generally leaves part of the pupal skin protruding from the case, as shown in Fig. 66. The male is



FIG. 66.—*Acanthopsyche* (*Metisa*) *moorei*.

an active little moth. The female has not yet been observed, but is likely to be a wingless grub-like insect, which passes her whole life within the case.

Locality from where reported.—This insect is thought to be the one that has been reported as attacking the gall-nut tree (? *Terminalia chebula*) in the Madras Presidency.

The insect is also said to do a great deal of damage in Calcutta as a defoliator, attacking *Lagerströmia* sp., and rose bushes, etc.

3. *Genus* (? *Clania*), *species*.

Tree attacked.—Sâl (*Shorea robusta*, Gærtn.).

Specimens of a *Psychid* larva were sent to the Indian Museum, in Calcutta, in June 1888, by Mr. C. V. Johnson from Ranchi, Chota Nagpur. He stated that they infested sâl, tea and other plants. This insect is probably closely allied to *Clania variegata* if it does not prove to be the same insect.

In 1894 the writer attempted to rear a *Psychid* caterpillar found attacking the sâl tree in the Singbhum sâl forests (about eighty miles south of Ranchi), but was unsuccessful in obtaining any imagoes. Owing to constant shifts of camp the larvæ and pupæ got so knocked about that they all died.

Families.—*Cossidæ*, *Hepialidæ*, *Limacodidæ*.

As in the case of the previously described family *Sesiidæ*, most of the larvæ of these three families are wood-borers; they bore into such valuable trees as *Tectona grandis*, *Santalum album*, and *Swietenia Mahogani*. They also do some damage as defoliators.

The following trees are attacked by these families:—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
COSSIDÆ .	1. Teak (<i>Tectona grandis</i> , Linn.) . .	Wood tunnelled into.
	2. Sandal-wood (<i>Santalum album</i> , Linn.) .	Do. do.
HEPIALIDÆ	1. Cinchona (<i>Cinchona</i> sp.) . .	Do. do.
	2. Teak (<i>Tectona grandis</i> , Linn.) . .	Do. do.
LIMACODIDÆ	1. Mango (<i>Mangifera indica</i> , Linn.) .	Defoliated.
	2. Mahogany (<i>Swietenia Mahogani</i> , Linn.)	Do. do.
UNKNOWN .	1. Charcoal Tree or { <i>Trema orientalis</i> , Bl. (= <i>Spomia orientalis</i> , Planch.)	{ Wood tunnelled into.
	2. Indian Nettle-tree { <i>Casuarina</i> , sp.	

Family VIII.—*Cossidæ*.

1. *Cossus cadambe*, Moore (or an ally of this species).

Moore, P. Z. S., 1865, p. 822; C. and S., No. 1582.

Tree attacked.—Teak (*Tectona grandis*, Linn.).

Egg.—The eggs are laid about the end of March in the rotten wood on the stems of the trees attacked.

Larva.—The larva is red in colour and not quite an inch in length, and is to be found in the wood from May onwards. It is stated that large mature larvæ are to be found at other times, so it is probable that more than one season is sometimes passed in this stage. The tunnel in the wood made by the larva is about the size of a quill and not at all straight.

Pupa.—The pupa is apparently not enclosed in a cocoon.

Imago.—The perfect insect emerges in the cold weather about March. Figure 67 shows the larva, pupa and imago of this insect.

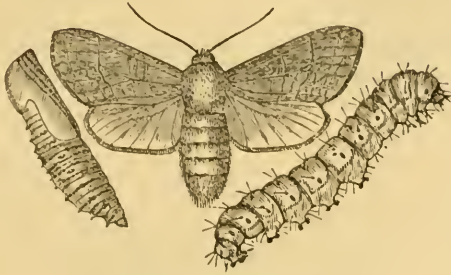


FIG. 67.—*Cossus cadambe*.

Locality from where reported.—Specimens of this pest were forwarded to the Indian Museum, Calcutta, by Mr. Bourdillon. It was reported as doing very serious injury to teak trees in Travancore by boring into the stems.

The following is an extract from Mr. Bourdillon's letters on the subject¹ :—

"The teak tree occurs in Travancore, and is found over considerable areas both in the low country and on the hills up to 3,000 feet elevation. It attains very large dimensions (five feet in diameter), and grows to a great age at moderate elevations (1,000 feet or so) and on well-drained situations, but in the low country it seldom grows much above fifteen inches in diameter, the timber here being much heavier and the concentric rings much closer together than when the tree grows on the hills. This is probably due more to its growing on a hard laterite soil than on the difference in elevation.

"This small stunted teak is very much troubled by a species of red borer, not quite an inch long, which perforates the wood, chiefly in the neighbourhood of the old branches, and of course very much lowers its value . . .

"This boring is entirely due to the dreadful system of lopping teak to manure the paddy fields, which prevails in Travancore. . . The trees are lopped in May and June just when they are in full leaf, little snags being left by the people by which to climb up. These snags die back, and as the sap is in full flow a new branch is thrown out at the side of the old one, which is in turn cut back, so that gradually large spaces of soft rotting wood about

¹ The first of these letters was published in the *Indian Forester* for July 1889.

ten inches square are left at intervals all up the tree. This soft wood is seized on by some insect which lays its eggs there, and in time borers riddle the wood. They work in and down to the distance of eight to nine inches, and are to be found at work about May and June

"The trees thus attacked die down after a time from the top, and eventually no part of them remains alive but the base of the stem, from which suckers are thrown up.

"The wood is of course completely damaged for furniture or ordinary work, but when the trees are not badly damaged they can be used for rough work, such as posts, though they are of course permanently disfigured.

"There can be no doubt that the damage is caused entirely by the lopping of the trees, for in the forest where the teak is not subject to this ill-treatment, the trees do not suffer in the least."

The above is a good illustration of how enforced bad management of a forest brings about and assists insect attacks, which, under a different procedure, could be kept at bay, if not entirely obviated.

2. *Zenzera coffeæ*, Nietner.

Nietn. *Edin. New Phil. Journ.* XV, 1862, p. 36; *C. and S.*, No. 1588; *Moore Lep. Ceyl.* ii, pl. 143, figs. 1, 1a, b (larva).

Tree attacked.—Sandal wood (*Santalum album*, Linn.).

Egg.—The eggs are laid by the female in the bark of the tree.

Larva.—The larva is two inches in length and as thick as a goose quill, nearly naked and yellowish in colour, back red, head, thoracic, and anal plates blackish; when full grown the colours are light and dirty. On emergence from the egg the young larvæ tunnel their way into the heart of the tree. It is stated that when they attack tea bushes the larvæ are at first found in the smaller twigs, but as they grow bigger they make their way into the main branches and stem. The presence of the insect may usually be detected by the sickly drooping foliage and the heaps of saw dust like excrement to be found on the ground under the tree attacked. The larva is stated to bore into both the stem and the root of the sandal-wood, either killing the sapling outright or weakening it so that it is liable to get blown over by the wind. It is not improbable that the larval life is of more than one year's duration.

Pupa.—When full grown the larvæ proceed to the outer layers of wood and change into the pupal state near the mouth of the tunnel. The pupa is said to rest three months, and the pupal skin half protrudes from the hole when the imago escapes.

Imago.—The moth measures one and three-quarter inches

across the wings, which are white spotted with steel blue; the upper ones with one large spot and numerous series of small ones

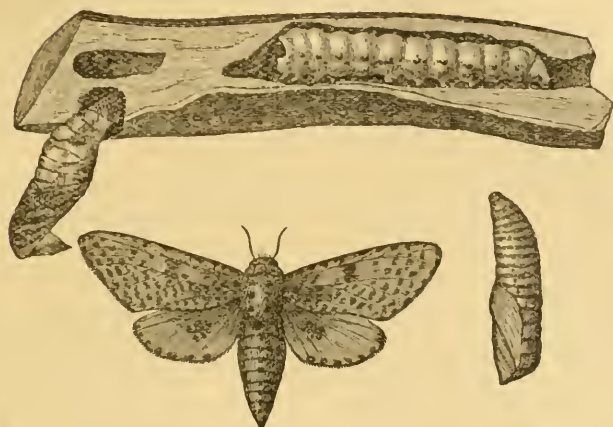


Fig. 68.—*Zenzera coffea*.

placed in rows between the nerves; the lower wings are less spotted; thorax with four spots near the margin; abdomen variegated with blue; legs blue. The moth emerges in February. Mr. Green, however, notices that in Ceylon the moths are found at several other times of the year. Figure 68 shows a caterpillar inside a tunnel in the wood, also a chrysalis and a chrysalis case protruding from a tunnel, and the moth, all natural size.

Locality from where reported.—The pest was reported by the Assistant Conservator of Forests, Mysore, in 1891 as attacking and seriously damaging sandal-wood. He stated that saplings of this tree were either killed outright or so weakened by the attacks of this pest that they were thrown down by the wind. As this tree yields an important revenue to the Mysore State, this damage done to the young trees was of consequence.

Mr. J. Cameron also found sandal-wood trees being attacked in the Botanical Gardens at Bangalore, and sent some of the affected stems to the Indian Museum, Calcutta. The identity of the insect, which also proved to be *Zenzera coffea*, was ascertained from a moth that emerged in the Museum from these stems.

The chief points which remain to be ascertained about the life history of this pest are the dates of emergence of the moth, and the period spent in the various stages, particularly the number of months or years spent by the larva tunnelling in the tree.

Family IX.—*Hepialidæ*.

In this family the damage is done by the insect, in the larval state, boring into the wood of trees.

1. *Phassus pupurascens*, Moore.

Moore, *Lep. Ceyl.* ii, p.156, pl. 143, fig. 4 ; C. and S. No. 1620.

Tree attacked.—Cinchona (*Cinchona*, sp.).

Nothing much seems to be known about this insect. Its larvæ have been reported as tunnelling into Cinchona trees.

2. *Genus?* *species?*—

Tree attacked.—Teak (*Tectona grandis*, Linn.).

Specimens of a Heterocerous larva, probably belonging to the family *Hepialidæ*, were received in the Indian Museum, Calcutta, in January 1890 through the Madras Museum. The larvæ were reported as boring into the Government teak plantations in Nilamber, Malabar. No data on the life history of the pest seem to have been reported.

3. *Genus?* *species?*

Tree attacked.—Teak (*Tectona grandis*, Linn.).

Specimens of a caterpillar of a boring moth, together with pieces of teakwood bored by them, were sent to the Indian Museum by Mr. F. J. Branthwaite, Prome District, in December 1894. Mr. Branthwaite wrote as follows with reference to the pest:—

“ When visiting some plantations of teak this morning planted in the Prome Division in 1892, in company with the Conservator, Pegu Circle, and the Deputy Conservator of Forests, Tharrawaddy, we noticed that several of the young trees were attacked by some larvæ, two specimens of which are herewith sent.

“ The plantation where the larvæ were found was one planted in lines 12' x 3', the space intervening between the lines being overgrown with a fairly thick growth of various grasses.”

It was found impossible to identify the larvæ sent, but they were Lepidopterous and probably a *Hepialid*.

The larvæ, which are of a dirty cream colour with brown heads, are said to enter the stem of the young teak plant about one inch above the ground and then to bore right down into the tap root. They may be discovered by the heap of excreta present round the entrance of the hole.

This is another pest which should prove easy of identification if the officer in charge of the plantation collects the insect in all its stages of larva, pupa, and imago.

Family X.—*Limacodidae*.

The larvæ of this family do damage by defoliating trees.

1. *Natada velutina*, Kollan (or an allied species).

Koll. Hügel's Kaschmir, iv, p. 473 ; C. and S. No. 1274 ; Butl. Ill. Het. vi, pl. 102, fig. 1.

Tree attacked.—Mango (*Mangifera indica*, Linn.).

This insect has been reported as defoliating young mango trees in Poona.

Nothing further appears to be known about it.

2. *Genus ? species ?*

Tree attacked.—Mahogany (*Swietenia Mahogani*, Linn.).

Mr. J. Cameron of the Bangalore Public Garden wrote to the Indian Museum, Calcutta, on 16th January 1889, that they were being troubled by an insect which defoliated young mahogany plants. He was, he said, trying the experimental planting of mahogany ; a week or so ago the young plants had in many cases been stripped of their leaves by the pest.

The specimens received in the Museum were found to be the larvæ of a moth belonging to the family *Limacodidae*.

NOTE.—There are two other wood-boring *Heterocerus* insects which have not as yet been classified or put into their families for want of proper material to identify them by.

1. *Genus ? species ?*

Tree attacked.—Charcoal tree. (*Trema orientalis*, Bl. = *Spomia orientalis*, Planch.).

Some larvæ have been reported as very destructive to this tree in Southern India (Bidie).

2. *Genus ? species ?*

Tree attacked.—*Casuarina*, sp.

Specimens of an insect, probably belonging to this group, were forwarded to the Indian Museum, Calcutta, through the Director of the Forest School, Dehra Dun, from the Divisional Forest Officer, Chingleput, with the remark that they were found in the bark of *Casuarina* trees and were said to stunt their growth, although they did not kill the tree.

Family XI.—*Lymantriidae*.

This is another family containing defoliating larvæ. A species has been reported as defoliating the sâl (*Shorea robusta*), and consequently interfering with the growth of the tree over several hundreds of square miles at a time.

The following trees have been reported as suffering from the attacks of species of this family :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
LYMANTRIIDÆ	1. Sâl (<i>Shorea robusta</i> , Gærtn.) .	Defoliation.
	2. Makai (<i>Shorea assamica</i> , Dyer) .	Do.
	3. Mango (<i>Mangifera indica</i> Linn.) .	Do.
	4. Khumbi (<i>Careya arborea</i> , Roxb.) .	Do.

1. *Dasychira thwaitesii*, Moore.

Moore, *Lep. Ceyl.* ii, p. 98, pl. 116, fig. 1, 1a, b, (larva); *C. and S.* No. 991.

Trees attacked.—Sâl (*Shorea robusta*, Gærtn.), Makai (*Shorea assamica*, Dyer), and Khumbi (*Careya arborea*, Roxb.).

A description of a severe attack by this insect on the sâl forests (which they completely defoliated) in Assam in 1878 was given by Mr. W. R. Fisher, late Conservator of Forests in that Province, in the *Indian Forester*¹.

The following is an account of what is at present known of the life history of the pest.

Egg.—The egg is laid by the imago on the leaves of the sâl and other trees attacked.

Larva.—When full fed the larvæ are about one and a quarter to two inches long, covered all over with long, erect, yellow hairs, a thick bunch of which occurs on the dorsal aspect of each of the first four segments of the abdomen and also on the terminal segment; there is a black transverse stripe between the two anterior dorsal tufts. After it is full grown the larva spins itself up between the leaves of its food plant into a very scanty cocoon composed of its own hairs, which appear to be very easily detached, and which it binds together with silk.

Pupa.—After almost completely denuding itself of hairs to form the cocoon in which it encloses itself, the caterpillar creeps out of its larval skin and becomes a pupa. In the case of the February generation the insect remains in the pupal stage for rather less than a fortnight.

Imago.—The most noticeable feature about the moth is the difference between the sexes, the male being very much smaller and more brightly coloured than the female. Mr. Moore² describes the moth as follows :—

♂ fore wing greyish white, crossed by a basal, antemedial, and a postmedial, indistinct, black speckled sinuous duplex line, and a marginal side line, a lunular mark at the end of the cell,

¹ *Indian Forester*, Vol. VI, p. 243 (1881).

² *Lepidoptera*, Ceylon, Vol. II., p. 99.

the lines slightly dilated at the costal end; hind wing pale brown, the costal border and the cilia greyish white; thorax, head, palpi, and legs greyish white; abdomen pale brown; thorax slightly brown speckled; sides of head and palpi blackish; legs with black spots; antennæ ochreous brown, shaft white.

♀ fore wing greyish white irrorated with numerous brown scales, the transverse sinuous lines much less defined, being mostly apparent at the costal end, and composed of scattered brown scales; hind wing white with a few brown scales from the anal angle; body greyish white; thorax brown speckled; legs and antennæ as in the ♂.

Expanse—♂ $1\frac{1}{2}$ inches; ♀ $2\frac{3}{4}$ inches.

The insect appears to be singularly subject to the attacks of parasites. A considerable number of cocoons sent to the Indian Museum, Calcutta, were destroyed by parasites, *tachnid* flies and species of *Chalcidæ* being the chief ones identified. Mr. Fisher also wrote on this subject:—

“I collected several hundred chrysalids, intending to send specimens for identification, but they all died, whether from a disease or *ichneumon*s I cannot now determine. Since May 1879 I have not noticed a single specimen of the insect.”

Plate VIII (1) shows the male and female moths, the cocoon partially wrapped in a leaf, the chrysalis extracted from the cocoon, and the caterpillar, all natural size.

Locality from where reported.—As above mentioned, Mr. Fisher wrote an account in the *Indian Forester* of an insect, subsequently proved to be *D. thwaitisii*, that defoliated sâl trees in the Eastern Duars and Goalpara in 1878. He wrote that in the commencement of October 1878 every leaf of the sâl trees, in a forest of about two hundred square miles in extent, had been devoured. In this tract, which is situated on a raised plateau of red loam and gravel, and is called the Purbotjuar and Guma forests, and in which sâl almost everywhere constitutes the predominant species, the foliage was so completely destroyed that the sâl trees were rendered perfectly bare of leaves and the ground was strewn with their débris and with the caterpillars' dung.

The caterpillars, however, prevailed over a much larger area, the more westerly forests in the plains of the Eastern Duars suffering the most. Other trees were also attacked, especially *Careya arborea*, and even the tea plants of a garden which had been lately opened out in the neighbourhood of the forest.

From some of the villagers Mr. Fisher also learnt that there had been similar attacks of caterpillars within their memory

He observed that a large portion of the Sidli forests escaped damage, and that elsewhere patches where the forest growth was densest and finest, and probably the soil and air dampest, had also escaped, whilst in the forests of more scattered growth and where trees had been damaged by jungle fires, the leaves were all stripped off. This Mr. Fisher thought might perhaps have been due to the inability of the larva to feed on leaves full of strong acrid juice which would be found in the more vigorous portions of the forest. This fact that vigorous trees are not attacked is worthy of consideration, as it seems to be a general law with most insect pests.

Mr. T. J. Campbell also alludes as follows to this insect in the *Indian Forester*.¹ The attack was in the Goalpara district. "Considerably surpassing this" (other damage done) "is the wholesale defoliation of sâl by the Lepidopterous *Dasychira thwaitisii*, nor has it confined its ravages to this individual tree, but has invaded all the associated species, particularly *Bombax malabaricum*, *Careya arborea*, and *Dillenia pentagyna*. Their depredations include lower hill forest and mixed plain forest, deciduous or evergreen. Small in proportion as the latter class of forest is, confined to narrow margins along banks of streams, it has not escaped the common enemy. The forest growing on an almost laterite clay, that on the richer loam of the submontane regions, that of more recent formation resulting from scourings of disintegrated igneous rocks, or that on the humus clad surface, with a poor sandy subsoil impregnated with mica, have all suffered in varying degrees. Pure sâl forest, however, suffered more than mixed, as did forest growing on the lighter poorer soil. The area estimated as being affected cannot be less than 800 square miles, and no sâl forest whatever has escaped on the north of the Brahmaputra."

"As far back as 1878 Mr. W. R. Fisher, now at Cooper's Hill, reported the defoliation of 200 square miles of sâl forest by this same pest. His description of the caterpillar was not quite correct, as it is covered with long, erect, yellow hairs with a black transverse stripe, the moth being a fluffy greyish white.² It is possible too that he under-estimated the area affected, as his observations closed early."

Mr. Campbell then mentions that the insect is present every year, and continues: "Its power for mischief has been miscalculated, however, as the sudden arrest of growth at its most active period of vitality has resulted in the death of a large number of new shoots, tender twigs and branches, and the foliage of many trees presents the aspect of a severe burning. In addition to this, a year which opened with the promise of a most abundant seed-

¹ *Indian Forester*, Vol. XX, No. 7, pp. 256-257.

² The caterpillar may have been in another stage of growth, or the species may be different—*E. P. S.*

supply ends with a crop of which not more than 5 per cent. has seeded, the profuse inflorescence having suffered equally with the tender new leaves."

"In May and June 1892 a few specimens of these caterpillars were observed, but heavy and continuous rain falling early in the year possibly interfered with the further development and metamorphosis of the insect. In the following cold weather it was occasionally observed, but at about the close of March no less than 25 square miles were covered, the defoliation being complete. The operations were fragmentary, and of this area not more than two square miles were in one block. The insect confined itself to exposed situations, such as demarcated lines, fire lines, roads, etc., and trees growing on the poorest soils. That the affected area was not more extensive may be accounted for by the suggestion made in *Indian Museum Notes* that the parasite *Chalcis* (*Brachymeria*) *Euplaea*, and a species of *Perilampus* destroy the cocoons. The mere firing of the forest did not seem to retard the insect's energies much, as a portion of a sâl area badly burnt in February was not thereby excluded from the insect's favour. It is somewhat difficult to form an opinion regarding reasons for the wholesale appearance of the insect this year, but it is peculiar that like 1891-92 there was little cold weather rain followed by a long drought with very hot weather in the spring. In 1892-93 on the contrary, the rainfall was far above the average, and commenced on an extensive scale in March. It undoubtedly prevented the insect's expansion. The trees which suffered least as far as seed bearing is concerned were the more mature, robust ones."

With reference to the periodical increase and consequent invasion of this insect it is probable that in a wet and cold year it is weakly and much less able to withstand parasitical attacks. In such years these obtain the upper hand, and the insect seems to have disappeared. This is probably what took place in 1892-93.

NOTE.—In Europe the Pale Tussock moth (*Dasychira pudibunda*) larva in a similar manner does extensive damage in beech forests.

The foliage is at first only skeletonised, but after August the leaves are almost entirely eaten, or the petioles are eaten through and the leaves fall to the ground. The damage done consists in loss of increment and reduction in the production of seed as fewer flower-buds are developed; the quantity of beech-mast is much diminished and the nuts are often empty. This is highly prejudicial to beech forest under natural reproduction.

2. *Euproctis scintillans*, Wlk.

Wlk. *Cat.* vii, p. 1734; *Bull. Ill. Het.* v., pl. 90, fig. 1; *C. and S.* No. 924 = *Artaxa limbata*, *Bull. Ill. Het.* v., p. 53, pl. 90, fig. 3; *C. and S.* No. 915.

Tree attacked.—Mango (*Mangifera indica*, Linn.).

Egg.—This stage does not seem to have been noticed.

Larva.—Larvæ were found attacking young mangoes on the 23rd September. They are dark brown in colour with a series of crimson lateral tubercles on a yellow line bearing tufts of grey hair.

Pupa.—The cocoons were spun on the 29th September.

Imago.—The moths emerged on the 12th October.

Head-yellow; thorax brown; abdomen black or yellow, the anal tuft orange. Fore wings vinous brown, irrorated with dark scales, which colour extends as two spurs across the yellow marginal area below the apex and to the centre of margin, but sometimes not reaching the margin; costa often yellow. Hind wing yellow or in some specimens fuscous brown, with a broad yellow margin.



FIG. 69.—*Euproctis scintillans*.

margin.

Figure 69 shows one of the moths that was reared.

Locality from where received.—The specimens of this moth were received in the Indian Museum, Calcutta, from Mr. R. Wroughton, Conservator of Forests, Poona. He stated that the larvæ were injurious to young grafted mangoes. He reared the moth from the larvæ found.

3. *Genus? species?*—"Kulsi sâl caterpillar."

Tree attacked.—Sâl (*Shorea robusta*, Gærtn.).

The Deputy Conservator of Forests, Kamrup Division, Assam, forwarded to the Indian Museum, Calcutta, pupæ of a moth said to have suddenly appeared in vast swarms and denuded sâl trees in the Kulsi range of their leaves. This particular caterpillar had not been noticed previously, and the natives attributed the visitation to the successful protection of the forest from fire. Pupæ were found in the end of October 1889.

Imagoes appeared immediately afterwards and laid eggs which produced larvæ in the beginning of November, after which the pest seems to have disappeared for some time, moths and larvæ being again noticed, however, in the middle of December. Several attempts were made to rear the pupæ in Calcutta to enable the identity of the moth to be ascertained, but the only insects that emerged from the pupæ were Tachnid and Hymenopterous parasites, with which the pupæ seem to have been very much infested.

From the above description it will be seen that this insect has at least two generations in the year, and it is this prolificness that renders these pests most dangerous in Indian forests and harder to deal with.

Family XII.—*Noctuidæ*.

Defoliation is the chief damage done in Indian forests by this family of moths. These attacks on the foliage of trees are carried out by the larvæ, a few of the caterpillars have a limited wood-boring capacity, and another has been reported as tunnelling into the seed pods of trees.

The following trees have been reported as suffering from attacks of Noctuid insects :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
NOCTUIDÆ	1. Teak (<i>Tectona grandis</i> , Linn.) . . .	Defoliation.
	2. Silk cotton tree (<i>Bombax malabaricum</i> , D.C.).	Pods tunnelled into.
	3. Tallow tree (<i>Sapium sebiferum</i> , Roxb.)	Defoliation.
	4. Sâl (<i>Shorea robusta</i> , Gærtn.) . . .	Do.

1. *Agrotis ypsilon*, Rott.

Rott. *Naturf. XI*, p. 141.=*Agrotis suffusa*, Fabr.

Tree attacked.—Plants of all kinds.

This insect is mentioned here as it does an immense amount of damage, as the so-called “cut worm”, to crops and plants in India. The writer has been unable to find any reports of its having proved destructive in Indian forests; but as the changes which the systematic management of our forests will produce become more pronounced, it is not unlikely that this pest will make its appearance in forest nurseries and elsewhere.

The larvæ are earth-coloured grubs, which live in burrows in the ground. They sally out at night and cut off young plants, which they drag to their holes to feed on. Plate VIII(2) represents the imago and larva of this insect.

2. *Mudaria cornifrons*, Moore.

Moore, *Ind. Museum Notes iii*, p. 68.

Tree attacked—Silk cotton tree (? *Bombax malabaricum*, D.C.)

Egg.—Is probably laid on the flower or immature pods of the silk cotton tree in about February (the time would vary in different parts of India).

Larva.—The worm on hatching out tunnels into the pod and remains feeding in it till the pod falls to the ground. As soon as the pod reaches the ground the larva tunnels out of it into the soil and there constructs a typical *Noctues* cell of earth for the protection of the pupa. (This earthen cell is very characteristic of the hairless Noctuid larvæ; they almost invariably turn to the pupal state in the ground, and first build this earthen cell for their protection when in the chrysalis stage).

Pupa.—The insect probably hibernates in the pupal state within the earthen cell in the ground. It thus passes the longest part of its life in this state.

Imago.—The imagoes emerge in March at about the time the silk cotton trees are in flower in Calcutta. The moth is greenish in colour and about one and-a-half inches across the wings.

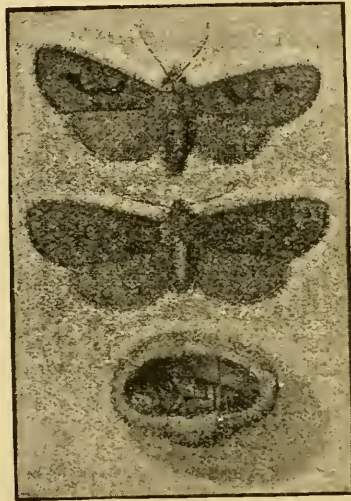


FIG. 70.—*Mudaria cornifrons*.

The male and female superficially resemble one another, but the female is lighter in colour. Figure 70 shows the male, female and the pupa lying in the earthen cell that the caterpillar makes in the ground, all natural size.

As the life history of the insect appears to depend on the

flowering and seeding of the silk cotton tree, the life cycle is of one year's duration and is shown diagrammatically as follows:—

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1897 .		†	† + -	- - ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●
1898 .	● ● ● ●	● ● ● ●	† + -	- -								

Locality from where reported.—This insect was reared in the Indian Museum, Calcutta, from silk cotton pods obtained in Calcutta. All the stages were observed. As yet the insect has not been reported as attacking this tree in other parts of India, but it is very likely that it does so unnoticed.

3. *Hyblæa puera*, Cramer.

Cram. Pap. Exot., pl. 103, figs. D, E; C. and S. No. 2232, Moore, Lep. Ceyl. iii, pl. 154, figs. 2, 2a (larva).

Tree attacked.—Teak (*Tectona grandis*, Linn.).

The following life history is drawn up from some notes by Lieutenant-Colonel Bingham on this insect:—

Egg.—Is not mentioned.

Larva.—Length a little over an inch; whitish yellow beneath, dusky greenish above; along the middle of the back is a pale flesh-coloured stripe with a darker smoky-brown one on each side; head dark brown; a few erect hairs scattered over each segment.

The larva makes its appearance in April and May, shortly after the flushing of the spring leaves and strips the leaves.

Lieutenant-Colonel Bingham writes:—

“My recollection is . . . that the larvæ appeared in the teak plantations about the 20th May, sometimes in almost incredible numbers” together with the *Pyralid* caterpillar, *Paliga damastalis*, Walker. “Their ravages were confined to certain areas, where they reappeared year after year, stripping the young teak of their leaves with the rapidity almost of locusts and hanging in thousands by webs to the branches of the trees.”

About the end of May the larvæ begin to let themselves down by silken threads to the ground to pupate.

Pupa.—The pupa is formed in a flimsy cocoon, which is often attached to dead leaves on the ground. The pupal stage lasts for about eight to eleven days.

Imago.—The imago is a small dusky moth with reddish markings on the hind wings; expanse of wings is about one

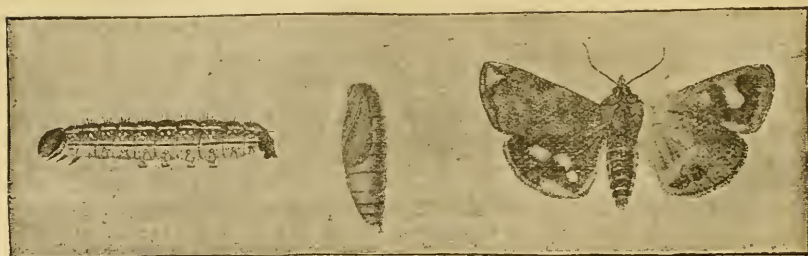


FIG. 71.—*Hyblaea puera*.

and-a-quarter inches. The moth is very like a large *Portia* in appearance. Figure 71 shows the larva, pupa, and imago of *H. puera*.

Locality from where reported.—This insect was reported by Lieutenant-Colonel Bingham of the Forest Service as stripping teak trees of their leaves in the teak plantations of the Rangoon Forest Division.

This pest is said to occur annually in that division, but Colonel Bingham notes that the larvæ have their enemies, as the attacked plantation is alive with jungle fowl, ground thrushes (*Pitta*) and insectivorous birds of all kinds.

In 1892 the pest was reported from the teak forests of the Hyderabad Assigned Districts. The attack was said to have been very severe in pure patches of teak forest, but was less noticeable in mixed forest. A good deal of damage was done during the rainy season. The trees attacked looked quite brown amongst the surrounding foliage and ultimately lost their leaves, but a new flush of leaves soon appeared.

In August 1893 damage was again occasioned to the teak forests of Berar by larvæ. Specimens were forwarded to the Indian Museum, Calcutta, by the Forest Department from Ellichpur. The larvæ first appeared on the 7th June, and commenced defoliating the teak trees.

The pest has also been reported as attacking teak trees in Delhra Dun, North-West Provinces, and in the Kuls plantation in Assam, and probably occurs wherever the teak grows throughout India. In Assam it was reported by "A. J. M." in the *Indian Forester*¹ to have appeared in May and September 1881 in the Kuls teak plantation, the leaves being entirely stripped off the trees.

¹ *Indian Forester*, Vol. IX, p. 366.

In the *Indian Forester*¹ Mr. Nisbet, writing on the injury done by this insect in the Pegu Circle (Burma), observes:—

“ These ravages. . . are really of very considerable importance. From April till July, when the summer flush of leaves comes, the increment in growth is lost almost entirely, and the later increment of the year must to some, and in all probability to a considerable extent, have been affected by the denudation of leaves previously. The occurrence of these attacks and details as to their magnitude do not yet find a place in our Annual Reports, although in all likelihood they do as much ” (or more ?) “ harm than a fire, unless the latter passes through a plantation where the accumulation of débris is great.”

4. *Ophuïsa melicerte*.—Drury.

Drury, *Ill. Exot. Ins.* 1, p. 46, pl. 23, fig. 1; Moore, *Lep. Ceyl.* iii, pl. 168, fig. 2, 2a, b (larva)=*Genus Achæa*, Hübn.

Tree attacked.—Tallow (*Sapium sebiferum*, Roxb.).

Egg.—No observations on the time and manner of laying the eggs seem to have been recorded.

Larva.—It has been noted that the larval stage lasts about fifteen days, the worms appearing just before the rains.

Pupa.—This stage is stated to last about ten days.

Imago.—According to the above observations the imago would appear on the wing at about the end of June or first week in July. No notes seem to have been recorded as to when the female lays her eggs, or of the number of generations, if more than one, passed through during the year.

Locality from where reported.—Injury by the larvæ of this insect was reported in August 1892 from Dehra Dun, North-Western Himalayas, and in October of the same year from Cuddapah in Madras.

In Dehra the insects appeared shortly before the rains and started eating the tallow tree leaves. When these were finished they let themselves down by silk threads on to tea bushes below and stripped these also.

The three following undetermined insects probably belong to the *Noctuidæ*.

1. *Genus ? species ?*

Tree attacked.—Sâl (*Shorea robusta*, Gærtn.).

In July 1893 specimens of insects reported as defoliating sâl forest in the Pilibhit Division were forwarded to the Indian Museum, Calcutta, through the Director of the Forest School, Dehra.

¹ *Indian Forester*, Vol. XVIII, pp. 46 to 48.

From a report of the local Forest Officer it appears that the larvæ were first noticed at the end of April over an area which had been recently burnt. Later on the insects spread throughout the entire area of the Pilibhit forests and stripped a large number of trees of their entire foliage. The attack seemed to be almost entirely confined to sâl trees.

Amongst the numerous miscellaneous insects sent to the Museum in connection with the attack numerous Noctuid larvæ were found, and these are likely to be the depredators. The material was however insufficient for identification.

Considering how destructive this defoliation has proved itself to be, advantage should be taken of the next attack to obtain good specimens of *all the stages of the insect* to enable it to be identified properly.

2. *Genus ? species ?*

Tree attacked.—Teak (*Tectona grandis*, Linn.).

Specimens of a larva which feeds on teak leaves were sent to the Indian Museum, Calcutta, by Dr. Tomes from Midnapur. The pest apparently only attacked the teak trees, leaving other kinds untouched. When full fed the larvæ rolled themselves up in the leaves to pupate at about the end of July. Specimens of the larvæ and pupa were sent, but no imago, and so it was impossible to identify the pest, which however somewhat resembled the cotton worm (*Aletia argillacia*) of America.

3. *Genus ? species ?*

Tree attacked.—Teak (*Tectona grandis*, Linn.).

Mr. Fernandez of the Forest Service states that teak trees over square miles of forest in the Central Provinces are sometimes completely defoliated during the latter half of the rainy season by larvæ which pass their pupal stage in the ground, and when alarmed on the trees drop themselves to the ground by silken threads.

This insect is probably a Noctuid larva and it should not prove difficult to get it correctly classified.

Family XIII.—*Geometridæ*.

The caterpillars of this family are the well known "loopers" and do some damage as defoliators.

The following trees are reported as attacked :—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
GEOMETRIDÆ	1. Teak (<i>Tectona grandis</i> , Linn.).	Defoliation.
	2. <i>Eucalyptus</i> sp.	Do.

1. *Bourmia trispinaria*, Walker.

Walker, Cat. Lep. Het. B. M. XXI, p. 378; Moore, Proc. Zoo. Soc., Lond., 1867, p. 630.

Tree attacked.—Teak (*Tectona grandis*, Linn.) and *Eucalyptus* sp.

Some imagoes reared from larvæ found feeding on teak and eucalyptus trees in Dehra Dun were forwarded to the Indian Museum, Calcutta, by the Director of the Forest School at Dehra in October 1892. The species sent presented a large range of individual variation, but one was found to be identical with a specimen in the Museum named *Boarmia trispinaria*, Walker.

No report as to dates of emergence from the various stages or of the time taken to pass through one generation of the insect seems to have been forwarded.

Families.—*Pyralidæ*, *Margaronidæ*, *Phycitidæ*, *Tineidæ*.

The following trees suffer from attacks of these families of insects:—

FAMILY.	TREE ATTACKED.	NATURE OF ATTACK.
PYRALIDÆ	1. Teak (<i>Tectona grandis</i> , Linn.).	Defoliation.
	2. Kulluk, Bamboo (<i>Bambusa vulgaris</i> , Wendl.).	Do.
	3. Male Bamboo (<i>Dendrocalamus strictus</i> , Nees.).	Do.
	4. Kaikar (<i>Garuga pinnata</i> , Roxb.).	Fruit tunnelled into.
MARGARONIDÆ	1. Mango (<i>Mangifera indica</i> , Linn.).	Do.
PHYCITIDÆ	1. Toon (<i>Cedrela Toona</i> , Twigs and seed tunnelled into. Roxb.).	
	2. Mahogany (<i>Swietenia Mahgoani</i> , Linn.).	Twigs tunnelled into.
TINEIDÆ	1. Tirmal (<i>Ficus Roxburghii</i> , Wall.).	Fruit tunnelled into.
	2. Deodar (<i>Cedrus Deodara</i> , Lond.).	Cones tunnelled into.
UNKNOWN	1. Salci (<i>Boswellia serrata</i> , Roxb.).	Wood tunnelled into.

Family XIV.—*Pyralidæ*.

This family has been reported as defoliators. The larvæ are also said to tunnel into the fruit of trees.

1. *Paliga damastesalis*, Moore.—Teak-leaf roller.

Moore, Lep. Ceyl. iii, p. 350 (1886).

Tree attacked.—Teak (*Tectona grandis*, Linn.).

Egg.—The eggs are probably laid on the leaves of the teak tree. There appear to be several generations of the pest during the year.

Larva.—Length of larva 0·7 of an inch to one inch; colour pale sap-green; two lines of purplish spots along the middle of the back; head yellow; a few pale erect hairs scattered over each segment. The larva feeds on the teak, stripping the tree of all its foliage. When ready to pupate it rolls itself up in the edge of a leaf, holding it in position by a few threads. The larvæ have been noticed as attacking teak in April and May and again in September and October.

Pupa.—The larva changes to the pupal stage within the rolled up teak leaf. The pupal state lasts for from eight to eleven days.

Imago.—The moth is a pearly-white insect with numerous tiny red spots and cross bands on the wings. Imagoes have been obtained in May and again in October. Figure 72 shows the imago, pupa, and the dorsal and side views of the larva.



FIG. 72.—*Paliga damastesalis*.

Locality from where reported.—This pest was reported as attacking and defoliating teak plantations in the Rangoon Forest Division by Lieutenant Colonel Bingham, of the Forest Department, in 1892. He wrote that in conjunction with *H. puera* (described under *Noctuidæ*) it did enormous damage.

In several cases these insects had been found working together, and in the Burma attacks *P. damastesalis* occurred in by far the greater numbers.

Both insects have also appeared in Berar in the teak forests of the Ellichpur Division. In August 1893 *Hyblæa puera* was sent to the Indian Museum, Calcutta, as damaging pure teak forests, and in October of the same year larvæ of *P. damastesalis* were sent and reported as having appeared in September and October

in the teak forests, which they had defoliated. This would probably be the second or third generation of the year.

"E. L." in the *Indian Forester*¹ mentions that all the teak in the Bairagarh and Gugumal Reserves in Berar were stripped by small caterpillars in this fashion in 1884.

P. damastesalis was reported to have done damage for the last three years in these forests. It is probable that both insects were present together, as there is no doubt that in the Burma attacks they work in company.

The insects are said to be particularly dangerous in pure teak forests. It is extremely important that the number of generations passed through by these insects during one year should be noted.

"J. N." in the *Indian Forester*² mentions that a bad attack by a Tortrix (Pyralid ?) took place in the Kyetpyoogon plantation of the Rangoon Division in 1884, and another in the Pyun Chaung plantation of the Toungoo Division in 1889. In both cases the entire foliage was destroyed in April and May. It was probably caused by these insects.

2. *Botys strenualis*, Walker.

Walker, *Cat. Lep. Het. B. M. XXXIV*, p. 1452, (1865) = *B. calesalis* Wlk.

Tree attacked.—Kulluk, (*Bambusa vulgaris*, W.) and Male Bamboo (*Dendrocalamus strictus*, Nees.).

Specimens of this insect were forwarded to the Indian Museum, Calcutta, by Mr. F. Gleadow from Poona in September 1893. The moth was said to frequent the bamboos, *B. vulgaris* and *D. strictus*, but had not up to then been noticed as doing any great damage.

The insect proved to be new to the Museum, and was forwarded to Mr. Hampson and by him identified as *B. strenualis*.

3. *Cenogethes punctiferalis*, Meyrick.

Meyrick, *Trans. Ent. Soc. Lond.*, 1884, p. 314; Moore, *Lep. Ceyl.* iii, p. 333 (1886).

Tree attacked.—Kaikar (*Garuga pinna'a*, Roxb.).

In May 1893 specimens of the fruit of *Garuga pinna'a*, attacked by insects, were forwarded to the Indian Museum from Poona by Mr. Marshall Woodrow. The fruit was found to be tunnelled by numerous small Microlepidopterous larvæ.

These larvæ were reared in the Museum, the moth emerging on the 26th May.

¹ *Indian Forester*, Vol. X, pp. 568-569.

² "The Tortrix of the teak tree" by "J. N." in the *Indian Forester*, Vol. XVIII, pp. 46-48.

Nothing further seems to have been reported about the pest.



FIG. 73.—*Conogethes punctiferalis*

Figure 73 shows the larva, pupa and imago of *C. punctiferalis*.

Family XV.—*Margaronidae*.

1. *Maruca* sp.

Tree attacked.—Mango (*Mangifera indica*, Linn.).

This insect has been reported as tunnelling into the mango fruit in Calcutta. It was submitted to Colonel Swinhoe for identification. He reported that the species was undescribed, and that the genus was allied to *Maruca*.

Family XVI.—*Phycitidae*.

The larvæ of this family have been reported as tunnelling into both the twigs and fruit of trees.

1. *Magiria robusta*, Moore.—Toon Twig Borer.

Moore, *Lep. Ceyl. iii*, p. 365, pl. 184, figs 4, 4a, (1886), *Ceylon*.

Tree attacked.—Toon (*Cedrela Toona*, Roxb.); Mahogany (*Swietenia Mahogani*, Linn.).

Egg.—Has not been described.

Larva.—Larvæ have been reported as appearing in India in June, but they do not appear to have been described. In Ceylon they are stated to be full fed in the latter part of September, when they spin a cocoon before changing to pupæ.

The damage is due to the larvæ mining along the succulent twigs and constantly destroying the leading shoot, and causing adventitious shoots to be given out on all sides. This goes on year after year, the leading shoot being constantly destroyed and the trees becoming a mass of stunted branches, with no well-defined trunk a few feet above the ground. The larva is chiefly found in young trees, but its work is only too apparent in the majority of old trees, very few of which have anything approaching a well-made trunk.

Pupa.—The pupæ are to be found in cocoons within the twigs at the end of September in Ceylon. In India they may apparently be found at the end of June.

Imago.—In India the moth would seem to appear on the wing in July, whilst in Ceylon imagoes were reared and appeared in October. It will probably be found that there are two or more generations of the insect during the year.

Locality from where reported.—In June 1893 a mass of matted silk containing numerous cocoons was sent through the Provincial Museum, Lucknow, from the Principal, Thomason College, Roorkee, to the Indian Museum, Calcutta. The Principal wrote that every toon tree in the station was covered with the matted silk from base to top. The insect was reared in the Museum and proved to be *Magiria robusta*.

The larva habitually spins a cocoon, but the formation of the web seems to be very unusual. Plate VIII (3) represents the larva, pupa and imago of this pest.

The following extract, signed "T. S. G.," is from the *Indian Forester*¹ and appears to apply to *M. robusta* :—

"The insect almost yearly attacks the young shoots of the toon tree, boring its way along the pith, which it seems to live upon, leaving behind it an unsightly looking mass of transparent gummy exudation. The larva is white with black and yellow spots . . . It attacks trees both in plantations and in the forests, and prefers those about three feet in height and of strong growth. It seems to attack, however, more particularly those trees which grow in cleared land or near roads, while others growing close by in grass or with other trees have been comparatively unharmed."

The pest has also been reported as attacking the small succulent branches of mahogany trees in the Western Duars.

In Nilambar, Madras, it was also said to attack the "succulent branches of experimental mahogany plants."

Larvæ of this insect were also obtained from the Museum of the Forest School, Dehra Dun, where they were marked as having in June 1886 proved destructive to the seeds of the *Cedrela Toona* tree.

Family XVII.—*Tortricidæ*.

This is a family of defoliators. They are characterised by the square shape of the upper wing. The larvæ feed inside a rolled up leaf.

In India this family have only as yet been reported as destructive to tea and coffee bushes. The family is mentioned here as in Europe some of its species are terrible pests and do a great deal of damage by defoliation. As our knowledge of Forest Entomology increases in India, it is not unlikely that some Tortrix enemies will be found at work in our Indian forests.

¹ *Indian Forester*, Vol. I, p. 197 (1876).

Family XVIII.—*Tineidae*.

This family contains the smallest existing moths. Their larvæ bore into the seed of trees, and the family may thus prove dangerous to stored seed.

1. *Genus? species?*

Tree attacked.—*Ficus Roxburghii*.

A species of *Tinea* has been reported to tunnel into the fruit of *Ficus Roxburghii* in Calcutta.

2. *Genus? species?*

Tree attacked.—Deodar (*Cedrus Deodara*).

Cones of *Cedrus deodara*, attacked by larvæ, were forwarded to the Indian Museum, Calcutta, through the Dehra Forest School from the Kulu Division in July 1892. The material was insufficient for identification, but it is not unlikely to prove a *Tinea* or *Tortrix*.

Hapsifera rugosella, Snell.

Snellen. *Tijd. Voor. Ent.* XXVIII, pl. II., figs. 1—4, 1884.

Tree attacked.—Salei (*Boswellia serrata*, Roxb. ex Colebr.)—

In January 1893 a small piece of *Boswellia serrata* wood was forwarded to the Indian Museum, Calcutta, by the Director of the Forest School. It was perforated in all directions with small round holes ranging from less than a millimetre to more than four millimetres in diameter. In these Coleopterous and Lepidopterous larvæ were found.

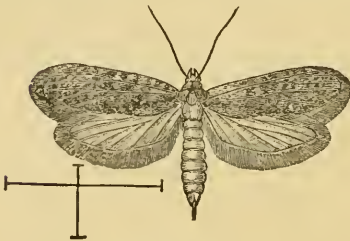


Fig. 74.

An imago was reared from the Lepidopterous larvæ. It proved to be a microlepidopterous moth, and was named as *H. rugosella* by Lord Walsingham. Figure 74 shows the imago. It is not considered likely, however, that this insect tunnelled into and damaged the wood.

NOTE.—*Genus? species?*

Tree attacked.—Himalayan Spruce Fir (*Picea Morinda*, Linn.).

The following is an account of the life history of an Heterocerous insect whose name is as yet undetermined. (It probably belongs to one of the last five families described.)

Egg.—The eggs of this insect do not appear to have been yet found, but the developing buds on which the larvæ feed grow about half an inch to one inch in length, and sometimes more before their further growth is stopped by the larvæ. This seems to point to

the egg being laid in the bud at the end of a terminal or side shoot in the rains or autumn; and to the egg (a solitary one) being laid in the middle of the bud, or at any rate at its base. Some leaves are developed before the egg is hatched and the larva emerges.

Larva.—Larvæ of this insect were found on June 7th. They were noticed feeding on the shoots of the tree. These shoots are not normally developed, the needles after growing from half an inch to one inch in length being formed into a pointed ovoid body, the free ends of the leaves being bound together so as to form a case. These needles are bound together with silk threads, and within the protective covering thus formed around the developing bud is the larva.

This protective covering is, on an average, two inches long, one quarter of an inch broad at the centre, and has very tapering ends. The further development of the bud is prevented by the covering of needles, which surround it on all sides, and the larva feeds on the tender partially-etiolated leaves, which are developed inside the covering of full-grown needles.

The average length of the larva is 0.31 inch and average width 0.05 inch; colour pale yellowish white, the skin being transparent and slightly hairy. The insect is very irritable when touched, and can give out a thin line of silk with which to suspend itself when required. It unites the outer and furthest developed leaves of the young shoots by silk threads in order to form a protection for itself and the developing bud on which it feeds.

It should be noticed that the bud scales, which form the protective covering of the bud during the winter, are pushed off as a whole by the developing bud and thus keep the free ends of the needle together, and it is only when the young shoot has developed to some extent from one to three inches that the bud scales fall off or are pierced by the needles of the young shoot. This method of development no doubt helps the larva to make his protective covering.

The larva changes to a chrysalis within the protective covering. There appears to be usually only one larva inside each case.

Pupa.—Some pupæ taken in the second week of June developed into moths in the beginning of July, the exact dates not having been noticed. One larva, which changed into the chrysalid state on the 7th—8th June, had not turned into a moth on the 7th July, so that they probably take a month on an average to develop from the pupa into the imago state.

The chrysalides seem to be very constant in length. The average of five measured was 0.25 inch.

The wing cases, antennæ, and eyes of the moth are clearly visible in the chrysalis.

The wing cases are about half as long as the whole chrysalis, which is light yellow when young, but matures to a light brown. The abdominal portion of the pupa shows seven segments. Three of these lie between the wing cases, and the remaining four are quite clear of the wing cases, each segment has two rows of small prickly-like protuberances on the back of the chrysalis, parallel to the segmental divisions of the body and close to the upper end (the one nearest the head) of the segment. One of the pupæ examined on the 7th June was found to contain the chrysalis of a fly which proved to be an Ichneumonid one, and is probably parasitic on the larvæ.

Imago.—The imago, of which no description appears to have been given in the report on the insect, emerges from the pupa in July. It seems to be common in the Jaunsar Forest Division, in the North-West Provinces, wherever the Spruce Fir is found, as signs of its presence were found at Deoban, Bodyar, Konain, and Mandate. It does not confine its attacks to small trees, but attacks large trees as well as small poles and saplings, and together with the fungus *Acidium abietum*, Barclay, does very serious damage to the Spruce. It apparently confines its attention to this tree, and does not attack the Deodar (*Cedrus Deodara*, Lond.), or Silver Fir (*Abies webbiana*) with which the Spruce is associated.

Locality from where reported.—In July 1894 the Director of the Imperial Forest School, Dehra Dun, forwarded specimens to the Indian Museum, Calcutta, of the larva, pupa, and imago of the above insect, which was reported to have been doing considerable damage to the Himalayan Spruce Fir (*Picea Morinda*, Link.) in the Jaunsar forest. The moth appeared to be new to the Museum collection, and has been sent to Europe for precise identification. It is not improbably a member of either of the Pyralid or Tineid families of the *Heterocera*.

A single specimen of an Ichneumonid fly was also sent with the specimens, and is probably a parasite on the larva.

The injury was discovered by Mr. C. G. Rogers, Deputy Conservator of Forests, and the above notes are taken from his report¹ on the subject.

Whilst in camp at Konain in April he noticed that the last year's shoots of small spruce saplings had been injured by something, as they had not developed at all. In June of the same year he noticed the larvæ at work on the new shoots at Bodyar.

Mr. Rogers remarks that in a pure spruce forest, more particularly a young one, this moth would undoubtedly develop into a very serious pest, and might endanger the very existence of the wood. Saplings have been noticed with nearly all their young shoots, including the leader, attacked by these larvæ, and spruce saplings in the advance growth, and saplings and poles suffering from want of light are at once attacked and their lives materially shortened.

¹ Indian Museum Notes, Vol. IV, No. 1, pp. 19–21.

It will be seen that a pest of this kind may do a large amount of injury in a forest, and may both affect the growth and production of wood of the larger trees, whilst at the same time killing off poles and suppressed ones.

APPENDIX A.

Alphabetical List of Trees, with Names of Insects by which they are attacked.

1. ACACIA ARABICA, Willd. *Babul*.—[Coleop.] *Celosterna spinata*, Fabr., p. 67; *Pachydissus holosericeus*, Fabr., p. 69; [Hemip.] *Carteria lacca*, Kerr., p. 16; *Genus ? species ?* (Pentatomidæ), p. 28.
2. ACACIA CATECHU, Willd., *Khair*.—[Coleop.] *Belionota scutellaris*, Fabr., p. 39; *Sinoxylon* sp. p. 41; *Stromatium barbatum*, Fabr. p. 73.
3. ACROCARPUS FRAXINIFOLIUS, Wight. *Mandania*, Nep.—[Hemip.] *Dactylopius adonidum*, Linn., p. 15.
4. ÆGLE MARMELOS, Correa. *Bael*.—[Lepid.] *Fapilio erithonius*, Cramer, p. 88.
5. ALBIZZIA PROCERA, Bth. *Safed Siris*, P.—[Coleop.] *Genus ? species* (Curculionidæ), p. 61.
6. ALBIZZIA sp.—[Coleop.] *Genus ? species ?* (Cerambycidæ), p. 80.
7. ALNUS NEPALENSIS, D. Don. *Utis*, P.—[Coleop.] *Anomala viridis*, Fabr., p. 37.
8. ANTHROCEPHALUS CADAMBA, Miq. *Kadam*, P.—[Coleop.] *Genus ? sp. ?* (Curculionidæ), p. 61.
9. ARECA CATECHU, Linn., *Suparee nut palm*.—[Hemip.] *Chionaspis aspidistræ*, Sign. p. 12.
10. ARUNDINARIA ARISTATA, Gamble. *Prengh bamboo*.—[Coleop.] *Odoiporus* sp. p. 59.
11. BAMBUA ARUNDINACEA, Retz. *Kaltung*.—[Hemip.] *Oregma bambusa*, Buckton, p. 20.
12. BAMBUA VULGARIS, Wendl. *Kulluk*.—[Lepid.] *Botys strenualis*, Walkr., p. 121.
13. BAMBUA sp.—[Coleop.] *Dinoderus* sp. p. 42.
14. BETULA CYLINDROSTACHYS, Wall., *Saur*. Nep.—[Coleop.] *Lucanus cantoris*, Hope, p. 34; *Genus ? species ?* (Scarabæidæ) p. 37; *Genus ? species ?* (Cerambycidæ) p. 80.
15. BOMBAX MALABARICUM, D. C. *Semul*.—[Coleop.] *Plocederus obesus*, Daporet (= *P. pedestris*, Cotes) p. 68; *Batocera* sp. p. 77; [Lepid.] *Mudaria cornifrons*, Moore, p. 113.
16. BOSWELLIA SERRATA, Roxb. ex Colebr. *Salei*.—[Lepid.] *Hapsifera rugosella*, Thunb., p. 124.
17. BUTEA FRONDOSA, Roxb. *Palas*, *Dhak*.—[Coleop.] *Sipalus granulatus*, Fabr., p. 58; *Plocederus obesus*, Daporet, p. 68; [Hemip.] *Carteria lacca*, Kerr., p. 16.
18. CABEYA ARBOREA, Roxb. *Khumbi*.—[Lepid.] *Dasychira thwaitesii* Moore, p. 103.
19. CASEARIA TOMENTOSA, Roxb. *Chilla*.—[Hemip.] *Scutellera nobilis*, Fabr., p. 28.
20. CASTANOPSIS TRIBULOIDES, A. D. C., *Musre katus*, Nep.—[Coleop.] *Lucanus cantoris*, Hope. p. 34; [Hymen.] *Vespa* sp. p. 85.

21. *CASTANIA* *sp.*.—[Hemip.] *Psuedo-pulvinaria sikkimensis*, Atkinson, p. 16.
22. *CASUARINA* (?) *EQUISITIFOLIA*, Forst., *Beefwood of Australia*.—[Coleop.] *Genus ? species ?*. (Scarabaeidae) p. 36; [Lepid.] *Genus ? species ?* p. 107.
23. *CEDRELA* *TOONA*, Roxb., *Toon*.—[Lepid.] *Magiria robusta*, Moore, p. 122.
24. *CEDRELA* *sp.*.—[Hemip.] *Dactylopius adonidum*, Linn. p. 15.
25. *CEDRUS* *DEODARA*, Lond. *Cedar, Deodar*.—[Lepid.] *Genus ? sp. ?* (Tineidae) p. 124.
26. *CINCHONA*, *sp.*.—[Lepid.] *Phassus purpurascens*, Moore, p. 106; [Hemip.] *Psuedo-pulvinaria sikkimensis*, Atkinson, p. 16; *Pemphigus cinchona*, Buckton, p. 17; *Ceretaphis sp.* p. 20; *Helopeltis febriculosa*, Begroth., p. 30; *Disphinctus humeralis*, Walker, p. 30.
27. *COCOS* *NUCIFERA*, Linn. *Cocoanut Palm*.—[Coleop.] *Oryctes rhinoceros*, Linn., p. 37; *Rhynchophorus ferrugineus*, Oliv., p. 52; *Sphenophorus planipennis*, Gyll., p. 59; *Batocera rubus*, Linn., p. 77; [Lepid.] *Gangara thyrsis*, Fabr., p. 89; [Hemip.] *Aspidiotus destructor*, Sign. p. 13; *Dactylopius cocotis*, Maskell, p. 15.
28. *DENDROCALAMUS* *HAMILTONII*, Nees et Arnott. *Tama bans*, Nep.—[Coleop.] *Cryptotrachelus dux*, Bohem, p. 55.
29. *DENDROCALAMUS* *STRICTUS*, Nees., *Male bamboo*.—[Lepid.] *Botys strenuialis*, Walker, p. 121.
30. *DENDROCALAMUS* *sp.*.—[Coleop.] *Dinoderus sp.*, p. 42; *Estigmene chinensis*, Hope, p. 50.
31. *DILLENIA* *PENTAGYNA*.—[Lepid.] *Dasychira thwaitisii*, Moore, p. 108.
32. *ERYTHRINA* *SUBEROSA*, Roxb., *Roongra*.—[Coleop.] *Batocera sp.* p. 77.
33. *EUCALYPTUS* *sp.* *Australian gum tree*.—[Lepid.] *Boarmia trispinaria* Walker, p. 118.
34. *FICUS* *ASPERRIMA*, Roxb., *Karwat*.—[Hemip.] *Dactylopius adonidum* Linn., p. 15.
35. *FICUS* *GLOMERATA*, Roxb. *Kathgular*.—[Hemip.] *Dactylopius adonidum*, Linn., p. 15; [Hymen.] *Xylocopa sp.* p. 84.
36. *FICUS* *MYSORENSIS*, Heyne, *Sunkong-Kung*, L.—[Hemip.] *Dactylopius adonidum*, Linn. p. 15.
37. *FICUS* *RELIGIOSA*, Linn. *Pipal*.—[Lepid.] *Gunda sikkima*, Moore p. 91; [Hemip.] *Ceroplastes ceriferus*, Sign., p. 16; *Carteria lacca*, Kerr., p. 16.
38. *FICUS* *ROYBURGHII*, Wall., *Tirmal*.—[Lepid.] *Genus ? sp. ?* (Tineidae), p. 124.
39. *GARUGA* *PINNATA*, Roxb., *Kaikar*.—[Coleop.] *Genus ? sp. ?* (Buprestidae), p. 40; [Lepid.] *Conogethes punctiferalis*, Meyrick, p. 121; [Hemip.] *Phacopteron lentiginosum*, Buckton, p. 25.
40. *GMELENA* *ARBOREA*, Roxb., *Shivan tree*.—[Coleop.] *Calopepla leayana* Fabr., p. 51.
41. *LAGERSTROMIA* *sp.*.—[Lepid.] *Acanthopsyche (Metisa) moorei* Heyl., p. 101.
42. *LONICERA* *ANGUSTIFOLIA*, Wall., *Honey-suckle*.—[Coleop.] *Cantharis antennalis*, Marseul, p. 45.
43. *LONICERA* *QUINQUELOCULARIS*, Hardwicke. *Honey-suckle*.—[Coleop.] *Cantharis antennalis*, Marseul, p. 45.

44. *MANGIFERA INDICA*, Linn. *Mango*.—[Coleop.] Genus? sp.? (Buprestidae) p. 40; *Cryptorrhynchus mangiferae*, Fabr., p. 55; [Lepid.] *Euprocotis scintillans*, Walker, p. 111; *Natada vellutina*, Kollar, p. 107; *Maruca* sp. p. 122; (Hemip.) *Lecanium acuminatum*, Sign., p. 12; *Ceroplastes ceriferus*, Sign., p. 16; *Psylla cistellata*, Buckton, p. 24; *Idiocerus nivosus*, Lethierry, p. 26; *Idiocerus clypealis*, Lethierry, p. 27; *Idiocerus atkinsoni*, Lethierry, p. 27; [Dip.] *Dacus ferrugineus*, Fabr., p. 86 *Kivellia persicae*, Bigot., p. 86.
45. *MANIHOT GLAZIOVII*, Müll. Arg. *Ceara rubber*.—[Hemip.] *Lecanium nigrum*, Nietner, p. 12.
46. *MICHELIA* sp.—[Lepid.] *Antheraea assama*, Westw., p. 91.
47. *MORINGA PTERYGOSPERMA*, Gaerth. *Sanjna*.—[Coleop.] *Batocera* sp., p. 77.
48. *ODINA WODIER*, Roxb., *Jhingan*.—[Coleop.] *Plocederus obesus*, Daporet (= *P. pedestris*, Cotes) p. 68.
49. *PHENIX DACTYLIFERA*, Linn. *Dale-palm*.—[Coleop.] *Rhynchophorus ferrugineus*, Oliv., p. 52.
50. *PICEA MOBILDA*, Link. (= *Abies Smithiana*, Forbes.) *Himalayan Spruce Fir*.—[Hemip.] *Chermes abietis*, Linn., p. 22.
51. *PINUS LONGIFOLIA*, Roxb. *Chir*.—[Coleop.] Genus? sp.? (Buprestidae) p. 40; *Astycus lateralis*, Fabr., p. 57; Genus? sp.? (Scolytidae) p. 65. [Orthop.] *Caloptenus* sp., p. 2; *Chrotogonus* sp., p. 2; *Catanotops indicus*, Sauss. p. 3; *Edalus* sp. p. 3.
52. *PINUS EXCELSA*, Wall., *Kail*.—[Coleop.] *Polygraphus* sp., p. 63.
53. *PINUS GERARDIANA*, Wall. *Galjoga*.—[Coleop.] Genus? sp.? (Scolytidae) p. 65.
54. *PINUS KASTA*, Royle, *Dingsa*.—[Coleop.] *Pityogenes scitus*, Bland., p. 64.
55. *PISTACEA TEREBINTHUS*, Linn., *Terebinth tree*.—[Hemip.] *Pemphigus edificator*, Buckton, p. 17.
56. *POPULUS EUPHRATICA*, Olivier, *Poplar*, *Bahan*, Pb.—[Coleop.] Genus? species? (Buprestidae) p. 49; [Lepid.] *Trochilium omnataeformae*, Moore, p. 95; [Hemip.] *Pemphigus napæus*, Buckton, p. 18.
57. *POPULUS ? TREMULA*, Linn. *Aspen*.—[Hemip.] *Pemphigus immunis*, Buckton, p. 19.
58. *QUERCUS INCANA*, Roxb. *Rin*.—[Coleop.] Genus? sp.? (Scolytidae), p. 65.
59. *QUERCUS LAMELLOSA*, Sm. *Buk Lep. & Nep*.—[Coleop.] Genus? sp.? (Curculionidae) p. 61; [Lepid.] Genus? sp.? (Eupterotidae), p. 94.
60. *QUERCUS PACHYPHYLLA*, Kurz. *Bara katus*, P.—[Coleop.] Genus? sp.? (Curculionidae), p. 61.
61. *QUERCUS* sp.—[Coleop.] *Lucanus lunifer*, Hope, p. 32; *Diaprus impressus*, Janson, p. 62; [Hemip.] *Pseudo-pulvinaria sikkimensis*, Atkinson, p. 16.
62. *ROBINIA*, sp.—[Coleop.] Genus? sp.? (Cerambycidae) p. 80; [Orthop.] *Chrotogonus trachypterus*, Blanch., p. 3; *Edalus marmoratus* Thunb., p. 3; *Epacromia dorsalis*, Thunb., p. 4; *Acrotylus*, sp., p. 5.
63. *SALIX TETRASPERMA*, Roxb. *Wild Willow*, *Baishi*.—[Coleop.] *Batocera* sp., p. 77.
64. *SALIX ELEGANS*, Wall.—[Coleop.] *Melasoma* sp., p. 50.
65. *SANTALUM ALBUM*, Linn. *Sandal-wood*, *Chandan*.—[Coleop.] Genus? sp.? (Tenebrionidae) p. 46; [Lepid.] *Zeuzera coffea*, Nietner., p. 104.

66. *SAPIUM SEBIFERUM*, Roxb. *Chinese Tallow tree*.—[Lepid.] *Ophuisa melicerte*, Drury, p. 117.
67. *SCHIMA WALLICHII*, Choisy, *Chilauni*.—[Hemip.] *Helopeltis theiovora*, Moore, p. 28.
68. *SCHLEICHERA TRIJUGA*, Willd. *Kusm*.—[Hemip.] *Carteria lacca*, Kerz., p. 16.
69. *SHOREA ASSAMICA*, Dyer, *Makai*.—[Coleop.] *Pachydissus holosericeus* Fabr., p. 69; [Lepid.] *Dasychira thwaitisii*, Moore, p. 108.
70. *SHOREA ROBUSTA*, Gärtn. *Sal*.—[Coleop.] *Chrysobothris sexnotata* Gory, p. 38; *Sinoxylon anale*, Lesne, p. 42; *Sinoxylon* sp. p. 41; *Bostrychus jesuita*, Fabr. p. 42; *Genus? species?* (Curculionidæ), p. 60; *Genus? species?* (Scolytidæ), p. 65; *Calosterna scabrata*, Fabr. p. 66; *Plocoderus obsus*, Daporet, (*P. pedestris*, Cotes), p. 68; *Pachydissus holosericeus*, Fabr., p. 69; *Hoplocerambyx spinicornis*, p. 71; *Acanthophorus serraticornis*, Ol., p. 80; [Lepid.] *Dasychira thwaitisii*, Moore, p. 108; *Clania variegata*, Snell. p. 98; *Clania* sp. p. 101; *Antheraea paphia*, Linn., p. 90; *Antheraea frithii*, Moore, p. 91; *Genus? species?* (Noctuidæ), p. 117.
71. *SPONDIAS MANGIFERA*, Willd. *The Hogplum*, *Amara*.—[Coleop.] *Plocoderus obesus*, Daporet, (*P. pedestris*, Cotes), p. 68.
72. *STROBILANTHUS PECTINATUS*, T. And. *Kibu*.—[Coleop.] *Apion strobilanthes*, Desbroch, p. 59.
73. *SWIETENIA MAHOGANI*, Linn., *Mahogany*.—[Coleop.] *Genus? species?* (Curculionidæ), p. 60; [Lepid.] *Genus? species?* (Limacodidæ?) p. 107; *Magiria robusta*, Moore, p. 122.
74. *SYMPLOCOS THEÆFOLIA*, Ham., *Kharani*, Nep.—[Coleop.] *Lucanus mearesi*, Hope, p. 34; *Lucanus cantoris*, Hope, p. 34.
75. *TABERNACMONTANA* sp.—[Coleop.] *Sthenias grisator*, Fabr., p. 78.
76. *TAMARINDUS INDICA*, Linn. *Tamarind*, *Imli*.—[Coleop.] *Caryoborus gonagra*, Fabr., p. 49.
77. *TAMARIX ARTICULATA*, Vahl. *Farash*.—[Coleop.] *Pachydissus holosericeus*, Fabr., p. 69; [Hemip.] *Machærota* sp. p. 26.
78. *TECTONA GRANDIS*, Linn. *Teak*, *Sagun*.—[Coleop.] *Psiloptera fastuosa*, Fabricius, p. 38; *Pachydissus holosericeus*, Fabr., p. 69; *Stromatium, barbatum*, Fabr., p. 73; *Stromatium asperulum*, White, p. 76; *Ægosoma lacertosum*, Pascoe, p. 78; [Lepid.] *Cossus cadambe*, Moore, p. 102; *Genus? sp?* (Hepialidæ) p. 106; *Genus? sp?* (Hepialidæ) p. 106; *Hyblœa puera*, Cramer, p. 115; *Genus? sp?* (Noctuidæ), p. 118; *Genus? sp?* (Noctuidæ), p. 118; *Boarmia trispinaria*, Walker, p. 118; *Paliga damastesalis*, Moore, p. 119; [Hymen.] *Genus? species?* (Cynipidæ), p. 16.
79. *TERMINALIA BELEBICA*, Roxb., *Bahera*.—[Coleop.] *Sinoxylon* sp. p. 41.
80. *TERMINALIA CHEBULA*, Retz., *Harra*.—[Lepid.] *Acantopsyche (Metisa) moorii*, Heyl. p. 101; [Hemip.] *Ceroplastes ceriferus*, Sign., p. 16.
81. *TERMINALIA TOMENTOSA*, W. & A. *Saj*, *Asan*.—[Coleop.] *Pachydissus holosericeus*, Fabr., p. 69; [Lepid.] *Antheraea paphia*, Linn., p. 90; [Hemip.] *Ceroplastes ceriferus*, Sign., p. 16.
82. *TEMA ORIENTALIS*, Bl.(= *Spomia orientalis*, Planch.). *Charcoal or Indian Nettle tree*.—[Lepid.] *Genus? sp?* (Limacodidæ), p. 107.
83. *WRIGHTIA TINCTORIA*, R. Br., *Dudhi*.—[Coleop.] *Xylorrhiza adusta* Wiedem. p. 79.
84. *ZIZYPHUS JUJUBA*, Lam., *Ber*.—[Lepid.] *Papilio erithonius*, Cramer, p. 88; *Antheraea paphia*, Linn., p. 90; [Hemip.] *Carteria lacca*, Kerr., p. 16.

APPENDIX B.

Trees on which the Lac Insect is reported to feed.

1. *Acacia arabica*, Willd, *Babul*.—In Sind and Guzerat yields large quantities of lac.
2. *Acacia Catechu*, Willd.
3. *Albizzia lucida*, Benth. *Silkori*, Beng.
4. *Aleurites molluccana*, Willd. *Akrot*.
5. *Anona squamosa* Linn., *Ata*.
6. *Butea frondosa*, Roxb., *Dhak*, *Palás*.
7. *Butea superba*, Roxb.
8. *Carissa carandas*, Linn.
9. *Celtis Roxburghii*, Bedd. Eastern Bengal, Central and Southern India.
10. *Ceratonia Siliqua*, Linn. The Carob tree; now almost naturalized in the Punjab and Southern India.
11. *Croton Draco*, Schlech.
12. *Dalbergia latifolia*, Roxb.
13. „ *paniculata*, Roxb.
14. *Dichrostachys cinera*, W. & A. The *Virtuli*, a shrub of Central and Southern India.
15. *Dolichandrone Rheedii*, Seem. A small tree of Burma and the Andamans.
16. *Eriolana Hookariana*, W. & A.
17. *Erythrina indica*, Linn.
18. *Feronia Elephantum*, Correa.
19. *Ficus bengalensis*, Linn.
20. „ *comosa*, Roxb., in Assam.
21. „ *cordifolia*, Roxb. Assam Lac.
22. „ *elastica*, Bl. The India Rubber Tree, *Bar*.
23. „ *glomerata*, Roxb.
24. „ *infectoria*, Willd. *Pakar* or *Keol*.
25. „ *laccifera*, Roxb. A native of Sylhet, the *Ruthal But*.
26. „ *religiosa*, Linn. *Aswat* or *pipal*.
27. *Garuga pinnata*, Roxb., *Kaika*.
28. *Kydia calcina*, Roxb., *Pola*.
29. *Lagerströmia parviflora*, Hook, *Bakli* or *Sida*.
30. *Mangifera indica*, Linn. The mango in its wild state often yields lac.
31. *Nephelium Litchii*, Camb. The *Lichi*.
32. *Ougeinia dalbergioides*, Benth., *Sandan*.
33. *Prosopis spicijera*, Linn. The *Jhand* of the arid zones of the Punjab and Guzerat.
34. *Pterocarpus Marsupium*, Roxb. *Bija* or *Kino* tree, a native of Central and South India.

35. *Pithecolobium dulce*, Benth. *Dakhini babul*.
36. *Schima crenata*, Korth. An evergreen of Burma.
37. *Schleichera trijuga*, Willd. *Kusm*. The most important of the lac trees.
It is a native of the Sub-Himalaya, Central, South India and Burma.
38. *Shorea robusta*, Gært. The tree coppices easily and so is good for lac cultivation.
39. *Shorea Talura*, Roxb. A native of Mysore.
40. *Tectona grandis*, Linn. Teak, a native of Central and South India, and Burma.
41. *Terminalia tomentosa*, W. & A. *Saj, Asan*.
42. *Zizyphus Jujuba*, Lam. *Ber*. This tree is especially used for propagation in the Punjab.
43. *Zizyphus zylopyra*, Willd. *Kat-ber*.

Extracted from the "Dictionary of Economic Products of India," by G. Watt, M.B., C.M., C.I.E., Volume II, pages 410 to 411.

INDEX OF SCIENTIFIC NAMES.

A	PAGE.
<i>Abies smithiana</i>	11, 22, 131
<i>Abies webbiana</i>	126
<i>Acacia arabica</i> , Willd.	27, 28, 47, 67, 68, 70, 71, 129, 133
<i>Acacia Catechu</i> , Willd.	31, 39, 41, 42, 47, 73, 76, 129, 133
<i>Acanthophorus serraticornis</i> , Oliv.	71, 80, 132
<i>Acanthopsyche</i> (Metisa) <i>moorii</i> , Heyl.	101, 130, 132
<i>Achæa melicerte</i> , Drury	117
<i>Acridium peregrinum</i> , Oliv.	1
<i>Acrocarpus fraxinifolius</i> , Wight	11, 15, 129
<i>Acrotylus</i> , sp.	3, 5, 131
<i>Acrydiidæ</i>	1—5
<i>Aculeata</i>	84, 85
<i>Æcidium abietium</i> , Barclay	126
<i>Ægle Marmelos</i> , Correa	88, 129
<i>Ægosoma lacertosum</i> , Pascoe	76, 78, 132
<i>Agrotis suffusa</i> , Hübn.	113
<i>Agrotis ypsilon</i> , Rott.	113, 152
<i>Albizzia procera</i> , Bth.	47, 61, 129
<i>Albizzia lucida</i> , Benth	133
<i>Albizzia</i> , sp.	48, 80, 129
<i>Aleurites moluccana</i> , Willd.	133
<i>Alnus nepalensis</i> , D. Don.	31, 37, 129
<i>Anomala viridis</i> , Fabr.	37, 129
<i>Anona squamosa</i> , Linn.	133
<i>Antheræa, assama</i> , Westw.	91, 131, 152
<i>Antheræa frithii</i>	91, 132
<i>Antheræa paphia</i> , Drury	90, 91, 132, 151
<i>Anthrocephalus cadamba</i> , Miq.	47, 61, 129
<i>Aphidæ</i>	11, 17—24
<i>Apidæ</i>	84, 85
<i>Apion strobilanthes</i> , Desbroch.	59, 60, 132
<i>Areca catechu</i> , Linn.	11, 12, 129
<i>Aristhala sikkima</i> , Moore	91, 92
<i>Artaxa limbata</i> , Butler	111
<i>Arundinaria aristata</i> , Gamble	59, 129
<i>Aspidiotus destructor</i> , Sign.	13—15, 130
<i>Astycus lateralis</i> , Fabr.	57, 58, 131
<i>Attacus atlas</i>	89

	B	PAGE.
<i>Babula grotei</i> , Moore		101
<i>Bambusa arundinacea</i> , Retz.		11, 20, 22, 129
<i>Bambusa vulgaris</i> , Wendl.		119, 121, 129
<i>Bambusa</i> sp.		31, 42—45, 129
<i>Batocera rubus</i> , Linn.		14, 77, 130
<i>Batocera</i> sp.		77, 78, 129, 130, 131
<i>Belionota scutellaris</i> , Fabr.		39, 129
<i>Betula cylindrostachys</i> , Wall.		31, 34, 35, 37, 48, 80, 129
<i>Boarmia trispinaria</i> , Walker		118, 119, 130, 132
<i>Bombax malabaricum</i> , DC.		47, 68, 69, 77, 78, 110, 113—115, 129
<i>Bombycidae</i>		90—92
<i>Bostrychidae</i>		31, 41—45, 95
<i>Bostrychus jesuita</i> , Fabr.		42, 71, 132
<i>Boswellia serrata</i> , Roxb.		119, 121, 129
<i>Botys coesalis</i> , Walker		121
<i>Botys strenualis</i> , Walker		121, 129, 130
<i>Brachycera</i>		86, 87
<i>Bruchidae</i>		46, 48—50
<i>Bruchus chinensis</i> , Linn.		48
<i>Bruchus pisi</i>		49
<i>Buprestidae</i>		31, 38—40
<i>Butea frondosa</i> , Roxb.		47, 58, 68, 129, 133
<i>Butea superba</i> , Roxb.		133

C

<i>Calopepla leayana</i> , Latr.		51, 130
<i>Caloptemus</i> sp.		2, 3, 131
<i>Cantharidae</i>		45, 46
<i>Cantharis antennalis</i> , Marseul		45, 46, 130
<i>Capsidae</i>		27—30
<i>Careya arborea</i> , Roxb.		108—110, 129
<i>Carissa carandas</i> , Linn.		133
<i>Carteria lacca</i> , Kerr		16, 129, 130, 132
<i>Caryoborus gonagra</i> , Fabr.		49, 50, 132
<i>Casearia tomentosa</i> , Roxb.		27, 28, 129
<i>Cassia fistula</i>		49
<i>Castanopsis tribuloides</i> , A. DC.		31, 34, 35, 84, 85, 129
<i>Castania</i> sp.		11, 16, 130
<i>Casuarina</i> sp.		31, 36, 102, 107, 130
<i>Catantops indicus</i> , Sauss.		2, 3, 131
<i>Cecidomyidae</i>		87
<i>Cedrela toona</i> , Roxb.		119, 122, 123, 130

Jedrela sp.	11, 15, 130
Cedrus Decadara, Lond.	119, 124, 126, 130
Celtis Roxburghii, Bedd.	133
Cerambycidæ	47, 48, 66—81, 95
Cerambyx vatica, Thomp.	69—71
Ceratonia Siliqua, Linn.	133
Cercopidæ	11, 26
Cerctaphis sp.	20, 130, 151
Ceroplastes ceriferus, Sign.	16, 130, 131, 132
Chalcis (Brachyneria) euplœa	111
Chermes abietis, Linn.	22—24, 131
Chionaspis aspidistræ, Sign.	12, 13, 129
Chrotogonus trachypterus, Blanch.	3, 131
Chrotogonus sp.	2, 3, 131
Chrysobothris sex-notata, Gory.	38, 132
Chrysomelidæ	46, 50—51
Cinadellidæ	11, 26, 27
Cinchona sp.	11, 16, 17, 20, 27, 30, 102, 106, 130
Clania variegata, Snell.	98—101, 132
Clania sp.	101, 102, 132
Coccidæ	11—16
Coccinellidæ	82
Coccus cacti, Linn.	16
Cocos nucifera, Linn.	11, 13, 15, 31, 37, 46, 47, 52—59, 77, 88, 89, 130
Cœlosterna scabrata, Fabr.	66, 67, 132, 151
Cœlosterna spinata, Fabr.	67, 68, 129
Coleoptera	31—82
Conogethes punctiferalis, Meyrick	121, 122, 130
Coreidæ	27, 28
Cossidæ	102—105
Cossus cadambe, Moore	102—104, 132
Croton Draco, Schlech.	133
Cryptorrhynchus mangiferæ, Fabr.	55—57, 131, 151
Curenlionidæ	46, 47, 51—62
Cynipidæ	83, 84, 87
Cyrtotrachelus dux, Bohern.	55, 130

D

Dactylopius adonidum, Linn.	15, 129, 130
Dactylopius cocotis, Maskell	13, 14, 15, 130
Dacus ferrugineus, Fabr.	86, 131
Dalbergia latifolia, Roxb.	133
Dalbergia pauciculata, Roxb.	133

	PAGE.
<i>Dasychira pudibunda</i>	111
<i>Dasychira thwaitisii</i> , Moore	108-111, 12, 130, 132, 152
<i>Dendrocalamus Hamiltonii</i> , Nees. et Arnot	46, 55, 130
<i>Dendrocalamus strictus</i> , Nees	119, 121, 130
<i>Dendrocalamus</i> sp.	46, 50, 130
<i>Diapus impressus</i> , Janson	62, 63, 131
<i>Dichrostachys cinerea</i> , W. and A.	133
<i>Dillenia pentagyna</i>	110, 130
<i>Dinoderus</i> sp.	42-45, 129, 130
<i>Diptera</i>	86, 87
<i>Disphinctus humeralis</i> , Walker	30, 130
<i>Dolichandrone Rheedii</i> , Siem.	133

E

<i>Elateridæ</i>	40-41
<i>Epracomia dorsalis</i> , Thunb.	3, 4, 5, 131
<i>Epilachna viginti-octo-punctata</i> , Fabr.	82
<i>Eriolaena Hookeriana</i> , W. and A.	133
<i>Erythrina indica</i> , Linn.	133
<i>Erythrina suberosa</i> , Roxb.	48, 78, 130
<i>Estigmena chinaensis</i> , Hope	50, 130
<i>Eucalyptus</i> sp.	118, 119, 130
<i>Eumeta sikkima</i> , Moore	98-101
<i>Eumeta</i> sp.	101, 102
<i>Euproctis scintillans</i> , Walker	1112, 131
<i>Eupterote minor</i> , Moore	93, 94
<i>Eupterotidæ</i>	93, 94

F

<i>Feronia Elephantum</i> , Correa	132
<i>Ficus asperrima</i> , Roxb.	11, 15, 130
<i>Ficus bengalensis</i> , Linn.	132
<i>Ficus comosa</i> , Roxb.	133
<i>Ficus cordifolia</i> , Roxb.	133
<i>Ficus elastica</i> , Bl.	133
<i>Ficus glomerata</i> , Roxb.	11, 15, 84, 130, 133
<i>Ficus infectoria</i> , Willd.	133
<i>Ficus laccifera</i> , Roxb.	133
<i>Ficus mysorensis</i> , Heyne	11, 15, 130
<i>Ficus religiosa</i> , Linn.	16, 90, 91, 130, 133
<i>Ficus Roxburghii</i> , Wall.	119, 124, 130

G

PAGE.

<i>Gangara thyrsis</i> , Fabr.	. . . . .	89, 130
<i>Garuga pinnata</i> , Roxb.	. . . . .	11, 25, 31, 40, 119, 121, 130, 133
Geometridæ	. . . . .	118, 119
<i>Gmelina arborea</i> , Roxb.	. . . . .	46, 51, 130
<i>Guuda sikkima</i> , Moore	. . . . .	91, 92, 130

H

<i>Hapsifera rugosella</i> , Snell	. . . . .	124, 129
<i>Helopeltis febriculosa</i> , Begroth	. . . . .	30, 130
<i>Helopeltis theiovora</i> , Moore	. . . . .	28—30, 132
Hemiptera	. . . . .	11—30
Hepialidæ	. . . . .	102, 106
Hesperidæ	. . . . .	88, 89
Heterocera	. . . . .	89—127
Heteromera	. . . . .	45, 46
Heteroptera	. . . . .	27—30
Homoptera	. . . . .	11—27
<i>Hoplocerambyx spinicornis</i> , Newm.	. . . . .	71—73, 81, 132, 151, 152
<i>Hyblæa puera</i> , Cramer	. . . . .	115—117, 120, 132
Hymenoptera	. . . . .	83—85

I

<i>Idiocerus atkinsonii</i> , Lethierry	. . . . .	27, 131
<i>Idiocerus clypealis</i> , Lethierry	. . . . .	27, 131
<i>Idiocerus niveosparsus</i> , Lethierry	. . . . .	26, 27, 131, 151

K

<i>Kydia calcina</i> , Roxb.	133
------------------------------	-----------	-----

L

<i>Lachnosterna impressa</i> , Burm.	. . . . .	35, 36
<i>Lagerströmia parviflora</i> , Hook.	. . . . .	133
<i>Lagerströmia</i> sp.	. . . . .	98, 101, 130
<i>Lecanium acuminatum</i> , Sign.	. . . . .	12, 131, 151, 152
<i>Lecanium nigrum</i> , Neitner	. . . . .	12, 131
Lepidoptera	. . . . .	88—127
Limacodidæ	. . . . .	102, 107
Locustidæ	. . . . .	1, 5
<i>Lonicera angustifolia</i> , Wall.	. . . . .	45, 46, 130

	PAGE.
<i>Lonigera quinquelocularis</i> , Hardwicke	45, 46, 130
Lucanidæ	31—35
<i>Lucanus cantoris</i> , Hope	34, 35, 129, 132
<i>Lucanus lunifer</i> , Hope	32—34, 131
<i>Lucanus mearesi</i> , Hope	34, 132
Lymantriidæ	12, 107—113

M

<i>Machærota</i> sp.	26, 132
<i>Macroductylus subspinosus</i> , Fabr.	35
<i>Magiria robusta</i>	122, 123, 130, 132, 152
<i>Mangifera indica</i> , Linn. 11, 12, 16, 34, 26, 27, 31, 40, 46, 55, 86, 102, 107, 108, 111, 112, 119, 122, 131, 133	
<i>Manihot Glaziovii</i> , Mull. Arg.	11, 12, 131
Margaronidæ	119, 122
<i>Maruca</i> sp.	122, 131
<i>Melanotus fuscus</i> , Fabr.	40, 41
<i>Melasoma</i> sp.	50, 51, 131
<i>Melolontha vulgaris</i> , Fabr.	35
<i>Michelia</i> sp.	90, 91, 131
<i>Moringa pterygosperma</i> , Gærth.	48, 78, 131
<i>Monoctonus soongna</i>	77, 78
<i>Mudaria cornifrons</i> , Moore	113—115, 129
Muscidæ	86, 87
<i>Mylabris</i> sp.	46

N

<i>Natada velutina</i> , Kollar	107, 131
Nemocera	87
<i>Nephelium Litchii</i> , Camb.	133
<i>Neocerambyx holosericeus</i> , Fabr.	69—71
Neuroptera	30
Noctuidæ	113—118

O

<i>Odina Wodier</i> , Roxb.	47, 68, 69, 131
<i>Odoiporus</i> sp.	59, 129
<i>Edalus marmoratus</i> , Thunb.	3, 4, 131
<i>Edalus</i> sp.	2, 3, 131
<i>Ophuisa melicerte</i> , Drury	117, 132
<i>Oregma bambusæ</i> , Buckton	20—22, 129
Orthoptera	1—10

	PAGE.
Orthoptera Genunina	1-5
Orthoptera Pseudoneuroptera	6-10
Oryctes rhinoceros, Linn.	14, 37, 52, 55, 130
Ougeinia dalbergoides, Benth.	133

P

Pachydissus holosericens, Fabr.	69, 70, 71, 76, 78, 129, 132, 151
Paliga damastesalis, Moore	115, 119-121, 132
Papilio erithonius, Cramer	88, 120, 132, 151
Papilionidæ	88
Pemphigus bursarius	20
Pemphigus cinchona, Buckton	17, 130
Pemphigus edificator, Buckton	17, 18, 131
Pemphigus immunis, Buckton	19, 20, 131, 151
Pemphigus napæus, Buckton	18, 19, 20, 131, 151
Pentamera	31-45
Pentatomidæ	27, 28
Perilampus sp.	111
Phacopteron lentiginosum, Buckton	25, 26, 130
Phassus purpurascens, Moore	106, 130
Phoenix dactylifera, Linn.	46, 52, 131
Phycitidæ	119, 122, 123
Picea Morinda, Link (=Abies Smithiana, Forbes)	11, 22, 124-127, 131
Pinus excelsa, Wall.	31, 45, 47, 63, 64, 131
Pinus Gerardiana, Wall.	31, 45, 47, 65, 131
Pinus kasya, Royle	47, 64, 65, 131
Pinus longifolia, Roxb.	1, 2, 3, 31, 40, 47, 57, 65, 151
Pistacea Terebinthus, Linn.	11, 17, 18, 131
Pithecolobium dulce, Benth.	134
Pityogenes scitrus, Eland.	64, 65, 131
Plocederus obesus, Gahan (=P. pedestris, Cotes)	68, 69, 72, 129, 131, 132, 151
Polygraphus sp.	63, 64, 131
Populus euphratica, Olivier	11, 18, 31, 40, 95, 97, 98, 131
Populus (?) tremula, Linn.	11, 19, 131
'Prionus'	32
Prosopis spicigera, Linn.	133
Pseudo-pulvinaria sikkimensis, Atkinson	16, 130, 131
Psiloptera fastuosa, Fabr.	38, 39, 132
Psychidæ	98-102
Psylla eistellata, Buckton	24, 25, 131
Psyllidæ	11, 24-26
Pterocarpus Marsupium, Roxb.	133
Pyralidæ	119-122

	Q	PAGE.
<i>Quercus incana</i> , Roxb.		47, 65, 131
<i>Quercus lamellosa</i> , Sm.		47, 61, 94, 131
<i>Quercus pachyphylla</i> , Kurz.		47, 61, 131
<i>Quercus</i> sp.		11, 31, 32, 47, 62, 131

R

<i>Rhopalocera</i>		88, 89
<i>Rhynohota</i>		11—30
<i>Rhyncophorus ferrugineus</i> , Oliv.		52—55, 130, 131
<i>Rivellia persicæ</i> , Bigot		86, 87, 131
<i>Robinia</i> sp.		1, 3, 4, 5, 48, 80, 131

S

<i>Salix tetrasperma</i> , Roxb.		47, 77, 131
<i>Salix elegans</i> , Wall.		46, 50, 131
<i>Saltatoria</i>		1—5
<i>Santalum album</i> , Linn.		45, 46, 102, 104, 131
<i>Sapium sebiferum</i> , Roxb.		113, 117, 132
<i>Saturniidae</i>		93, 91
<i>Scarabaeidae</i>		31, 35—37
<i>Schima crenata</i> , Korth.		134
<i>Schima Wallichii</i> , Choisy		27, 28, 132
<i>Schleichera trijuga</i> , Willd.		132, 134
<i>Schizodactylus monstrosus</i> , Brullé		5
<i>Scolytidae</i>		47, 62—66, 95
<i>Scutellera nobilis</i> , Fabr.		28, 129
<i>Sesiidae</i>		95—98
<i>Shorea assamica</i> , Dyer		65, 70, 71, 108—111, 132
<i>Shorea robusta</i> , Gärtn.	31, 38, 41, 42, 47, 60, 65, 66, 68—73, 80, 90, 91, 98—102, 107—113, 117, 118, 132, 134	
<i>Shorea Talura</i> , Roxb.		134
<i>Sinoxylon</i> sp.		41, 42, 129, 132
<i>Sinoxylon anale</i> , Lesne.		42, 71, 81, 132
<i>Sipalus granulatus</i> , Fabr.		58, 59, 129
<i>Spalyrta minor</i> , Moore		93, 94
<i>Sphacia omnatiæforme</i> , Moore		95—98
<i>Sphenophorus planipennis</i> , Nietner		59, 130
<i>Spondias mangifera</i> , Willd.		47, 68, 69, 132
<i>Sthenias grisator</i> , Fabr.		78, 79, 132
<i>Strobilanthus pectinatus</i> , T. And.		59, 132
<i>Stromatium asperulum</i>		3, 76, 77, 132

Page

<i>Stromatium barbatum</i> , Fabr.	73—76, 78, 129, 132
<i>Swietenia Mahogani</i> , Linn.	47, 60, 102, 107, 119, 122, 123, 132
<i>Symplocos theæfolia</i> , Ham.	31, 34, 35, 132

T

<i>Tabernaemontana</i> sp.	48, 78, 132
<i>Tamarindus indica</i> , Linn.	46, 49, 132
<i>Tamarix articulata</i> , Vahl.	11, 26, 47, 70, 71, 132
<i>Tectona grandis</i> , Linn. 31, 38, 47, 70, 73—76, 78, 83, 102, 106, 113, 115, 116 118—121, 132, 134	
<i>Tenebrionidæ</i>	46
<i>Tenthredinidæ</i>	83
<i>Terebrantia</i>	83—84
<i>Termes taprobanus</i> , Walker	6—10
<i>Terminalia belerica</i> , Roxb.	31, 41, 42, 132
<i>Terminalia Chebula</i> , Retz.	16, 98, 101, 132
<i>Terminalia tomentosa</i> , W. & A.	16, 47, 70, 90, 132, 134
<i>Termitidæ</i>	6—10
<i>Tetramera</i>	46—81
<i>Tineidæ</i>	119, 124—127
<i>Tortricidæ</i>	123
<i>Trema orientalis</i> , Bl. = <i>Spomia orientalis</i> , Planch.	102, 107, 132
<i>Trimera</i>	81, 82
<i>Trochilium omnatæforme</i> , Moore	95—98, 131

U

<i>Uroceridæ</i>	83
----------------------------	----

V

<i>Vespa</i> sp.	85, 129
<i>Vespidæ</i>	84, 85

W

<i>Wrightia tinctoria</i> , R. Br.	48, 79, 80, 132
--	-----------------

X

<i>Xyleborns perforans</i> , Wollaston	65, 66
<i>Xylocopa</i> sp.	84, 85, 130
<i>Xylorrhiza adusta</i> , Wiedem.	79, 80, 132
<i>Xylotrechus quadripes</i> , Chev.	80, 81

Z

<i>Zeuzera coffeæ</i> , Nietner	104, 105, 131
<i>Zizyphus Jujuba</i> , Lam.	88, 90, 132, 134
<i>Zizyphus zylopyra</i> , Willd.	90, 134

INDEX OF ENGLISH AND VERNACULAR NAMES, ETC.

A

PAGE.

Akrot	133
Amara	47, 68, 69, 132
Asan	16, 132, 134
Aspen	11, 19, 20, 131
Assam Lac	133
Aswat	133
Ata	133
Australian Gum Tree	130

B

Eabul	27, 28, 47, 67, 68, 70, 129, 133
Bael	88, 129
Bagworms	98—102
Bahan	131
Bahera	31, 41, 42, 132
Baishi	131
Bakli	133
Baluchistan Poplar borer	95—98
Bamboo	11, 31, 42—45, 46, 55, 119, 121
Bamboo borer	42—45
Bar	133
Bara katus, P.	47, 61, 131
Beech tree	111
Beefwood tree	130
Ber	88, 90, 132, 134
Bija	133
Black bug	12
Blister beetles	45, 46
Búk, Lep. & Nep.	47, 61, 94, 131

C

Carob tree	133
Cask borer	65, 66
Ceara rubber tree	11, 12, 131

	PAGE.
Cedar	119, 124, 126, 130
Chandan	131
Charcoal tree	102, 107, 132
Chestnut	11, 16
Chilauni, P.	27, 28, 132
Chilla	27, 28, 129
Chinese Tallow Tree	113, 117, 132
Chir	1, 2, 3, 31, 40, 47, 57, 65, 131
Cinchona	11, 16, 17, 20, 27, 30, 102, 106, 130
Click beetles	40
Cochineal insect	16
Cockchafer	35, 36
Cocoanut palm	11, 13, 15, 31, 37, 46, 47, 52, 54, 59, 77, 88, 89, 130
Cootee	43, 44
Cut worm	113

D

Dakhini babul	134
Date-palm	46, 52, 54, 131
Deodar	119, 124, 126, 130
Dhak	47, 58, 68, 129, 133
Dingsa	47, 64, 131
Dudhi	48, 79, 80, 132

F

Farash	11, 26, 47, 70, 132
------------------	---------------------

G

Galgoja	31, 47, 65, 131
Ghoong	42, 65

H

Harra	16, 132
Himalayan Spruce Fir	11, 22, 24, 124—127, 131
Hog plum	47, 132
Honeysuckle	45, 46, 130

I

Imli	132
Indian Nettle Tree	102, 107, 132
India-rubber Tree	133

	J	PAGE.
Jhand		133
Jhingan		47, 63, 69, 131

K

Kadam, P.		47, 61, 129
Kaikar	11, 25, 31, 119, 121, 130, 133	
Kail	31, 47, 63, 131	
Kaltung	20, 129	
Karwat	11, 130	
Kat-ber	134	
Kathgular	11, 84, 130	
Keol	133	
Khair	31, 39, 41, 42, 47, 73, 76, 129	
Kharani, Nep.	31, 34, 35, 132	
Khumbi	108—110, 129	
Kibu	59, 60, 132	
Kino	133	
Kulluk	119, 121, 129	
Kulsi Sal caterpillar	112	
Kulsi Teak borer	73—76	
Kusm	132, 134	

L

Lac insect	16
Ladybird beetles	82
Lichi	133

M

Mahogany	47, 60, 102, 107, 119, 122, 123, 132
Makai	65, 70, 71, 108—111, 132
Male bamboo	119, 121, 130
Mandania, Nep.	11, 129
Mango	11, 12, 16, 24, 25, 26, 27, 31, 40, 46, 55, 56, 86, 87, 102, 107, 108, 111, 112, 119, 122, 131
Mosquito Blight	23—30
Muga silk worm	91
Musre katus, Nep.	31, 34, 35, 84, 85, 129

O

Oak	11, 16, 31, 32—34, 47, 61, 62, 63, 65, 94
---------------	---

	P	PAGE.
Pakar		133
Palas		129, 133
Pale Tussock Moth		111
Palu weevil		52—55
Pola		133
Pipal		16, 130, 133
Poplar	11, 18, 31, 40, 95, 97, 98, 131	
Preng bamboo		59, 129

R

Rhinoceros beetle		37, 52, 55
Rin		47, 131
Roongra		48, 78, 130
Ruthal But		133

S

Safed siris, P.		47, 61, 129
Sagun		132
Saj	47, 70, 71, 90—132, 134	
Sal	31, 38, 41, 42, 47, 60, 65—73, 80, 85, 90, 91, 98—102, 107—113, 117, 118, 132	
Sal girdler		66, 67
Salei		119, 124, 129
Sandalwood	45, 46, 102, 104, 105, 131	
Sandan		133
Sanjna		48, 78, 131
Sauer, Nep.	31, 34, 35, 37, 48, 80, 129	
Scale insects		11—16
Semul	47, 48, 68, 77, 113—115, 129	
Shivan tree		46, 51, 130
Sida		133
Silkori		133
Silver Fir		126
Singbhum Sal borer		71—73
Spruce-gall aphid		22—24
Sunkong-Kung		11, 130
Suparee nut palm		11, 12, 129

T

Tallow Tree		113, 117
Tama bamboo, Nep.		130
Tamarind		46, 49, 50, 132

	PAGE.									
Teak . . .	31, 33, 39, 47, 70, 71, 73	-76, 78, 83, 84, 102, 106, 113, 115, 116, 118-121, 132, 134								
Teak-leaf roller										119-121
Terebinth tree										11, 131
Tirmal										119, 124, 130
Toon										119, 122, 123, 130
Toon-twigg borer										122, 123
Tusser silkworm										90, 91

U

Utis	31, 37, 129
----------------	-------------

V

Virtuli	133
-------------------	-----

W

White ant	6-10
White grub	35
White insect wax	16
Willow	46, 47, 50, 51, 77, 131
Wireworm	40

KEY TO THE PLATES.

PLATE I (1).—*Lecanium acuminatum*, Sign.

- (a) Dorsal surface, magnified about seven times.
- (b) Ventral surface.
- (c) Side view, magnified about seven times.

(2).—*Cerataphis* sp.

Larva and pupa enlarged.

(3).—*Idiocerus niveosparsus*, Lethierry.

- (a) Imago.
- (b) Larva.

PLATE II (1).—*Pemphigus napæus*, Buckton.

(2).—*Pemphigus immunis*, Buckton.

PLATE III (1).—*Cryptorrhynchus mangiferae*, Fabr.

- (a) Larva.
- (b) Pupa.
- (c) Imago (dorsal view).
- (d) Imago (ventral view): all enlarged.

(2) *Cælosterna scabrata*, Fabr.

Imago, natural size.

(3) *Plocedrus obesus*, Dap.

- (a) Imago ♀ natural size.
- (b) Imago ♂ head and thorax, natural size.
- (c) Calcareous pupa cell, natural size.

(4) *Pachydissus holosericeus*, Fabr.

- (a) Imago ♀ natural size.
- (b) Imago ♂ head and thorax, natural size.

PLATE IV.—*Hoplocerambyx spinicornis*, Newm.

- (a) Imago ♀ natural size.
- (b) Imago ♂ head and thorax.

PLATE V.—*Papilio erithonius*, Cramer.

- (a) Imago.
- (b) Pupæ.
- (c) Larva; all natural size.

PLATE VI.—*Antheræa paphia*, Linn.

- (a) Larva.
- (b) Pupa attached to a branch.
- (c) Imago ♂ and ♀: all natural size.

PLATE VII.—*Antheraea assama*, Westw.

- (a) Larva.
- (b) Pupa.
- (c) Imago ♂ and ♀: all natural size.

PLATE VIII (1).—*Dasychira thwaitisii*, Moore.

- (a) Imago ♀
- (b) Imago ♂
- (c) Cocoon on a leaf.
- (d) Pupa.
- (e) Larva (dorsal view).
- (f) Larva (side view): all natural size.
- (g) *Chalcis euplæa*, Hope (enlarged)
- (h) *Ferilampus*, new species (enlarged) } parasites.

(2) *Agrotis ypsilon*, Rott.

- (a) Larva (natural size).
- (b) Larval head (enlarged).
- (c) Imago (natural size).

(3) *Magira robusta*, Moore.

- (a) Imago.
- (b) Pupa.
- (c) Larva in a toon twig: all natural size.

PLATE IXa.—*Chermes abietis*, Linn.

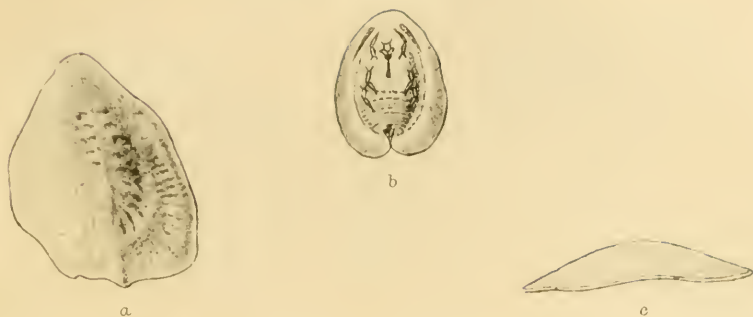
Gall of *Chermes abietis* on a spruce twig.

b.—*Genus?* sp.? (Curculionidæ)—

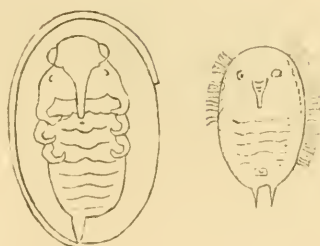
- (a) Piece of wood with bark removed showing cocoon made of rough chips beneath, natural size.
- (b) Pupa inside cocoon, natural size.
- (c) Pupa, ventral surface, natural size.

c.—*Hoplocerambyx spinicornis*, Newm.

Larva.



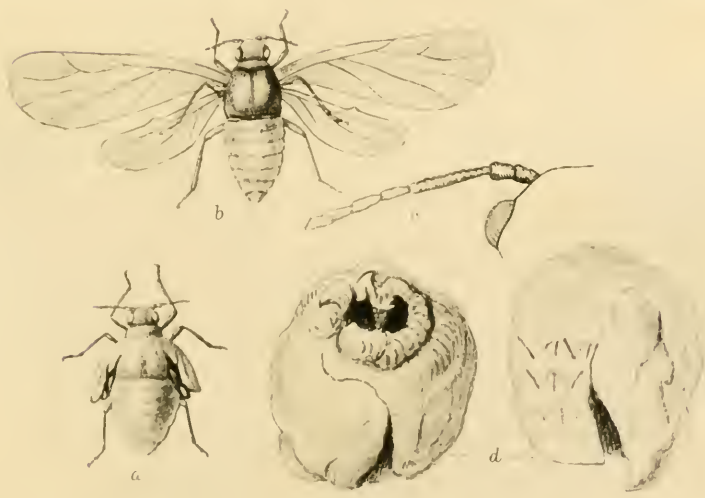
1. *LECANIUM ACUMINATUM* SIGN.



2. *CERATAPHIS* SP.



3. *IDIOCERUS NIVEOSPARSUS*, LETHIERY.

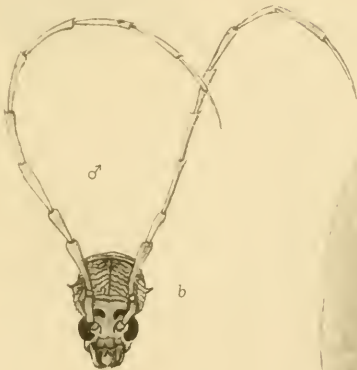


C. Chakrabarty, del. Survey of India Offices Calcutta, July 1913.

1. PEMPHIGUS NAPEUS 2. PEMPHIGUS IMMUNIS



1. CRYPTORRHYNCHUS MANGIFERA, FABR. THE MANGO WEEVIL.



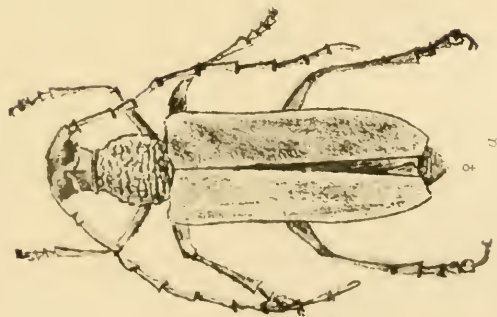
SAL GIRDLER
2 C. ELOSTERNA SCABRATA, FABR.



4. PACHYDISSUS HOLOSERICEUS, FABR.



3 PLOCEDERUS OBESUS, DAP



HYPOCLETHRAX SPINICORNIS, NEWN





a



b



c

PAPILIO ERITHONIUS CRAMER



TUSSER.
Antharaea paphia Linn

G.C.Chuckrabhoy del.

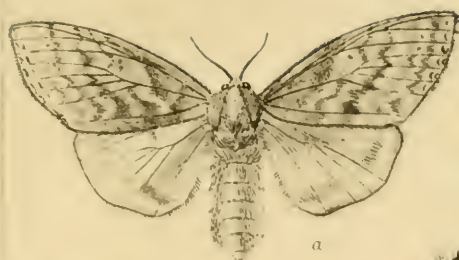
Photo etching from the original pencil Drawing. Survey of India Offices, Calcutta, July 1898.



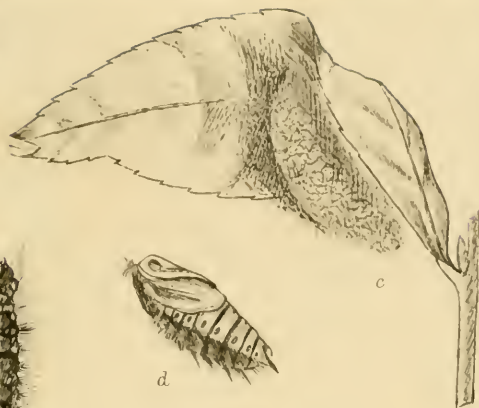
MUGA.
Antheraea assama, Westw.

G C. Chackrabotly, del

Photo-etching from the original pencil Drawings - Survey of India Offices, Calcutta, July 1898.



a



c



b



e



d



f



1 SAL AND TEA PEST.

PSYCHIRA THWAITESII, MOORE, WITH PARASITES.



h



c



a

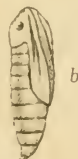


b



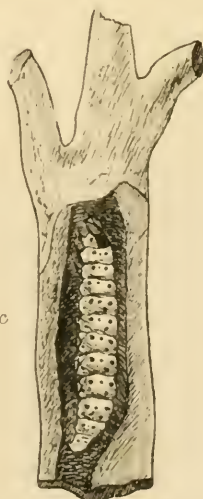
a

2 CUT WORM
AGROTIS YPSILON, ROTT

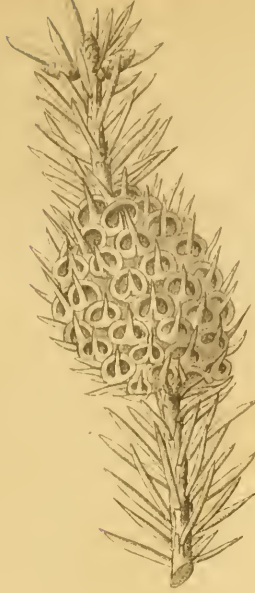


b

3. TOON BORER
MAGIRA ROBUSTA, MOORE.



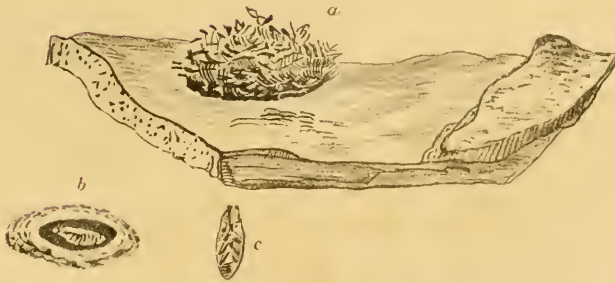
c



a

Gall of *Chermes abietis*, L.
on a Spruce twig,
nat. size.

Fig. 41.



- a. Piece of wood with bark removed showing cocoon
made of rough chips beneath.
- b. Pupa inside cocoon.
- c. Pupa.

Fig. 49.



c



